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THE DEVELOPMENT OF OUR KNOWLEDGE OF NUTRITION [1]

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Nutrition may well claim to be the oldest branch of knowledge, for problems of food have beeen the subject of interest and investigation since the first dawn of conscious life. We have no written records of the primitive investigations of our progenitors, but the countless past generations of both animals and man have accumulated a vast experience which finds expression in inherited food instincts and traditional dietary customs. These continue to form a more or less reliable guide to practice.

That instincts should serve as a guide under ordinary circumstances when animals are in health and when food of the right kind is easily available, is in itself remarkable. But they give expression to the accumulated experience of the ages in even more incomprehensible ways. In abnormal conditions when the food available is short in some particular constituent, these instincts often guide the animal to find and consume the lacking constituent even though it be available only in a substance which the animal's experience would not lead it to regard as a food. Wild animals will trek long distances to salt licks to obtain some food constituent which the pastures they are grazing do not supply in sufficient amount. Even domesticated animals retain these instincts. Cattle grazing on pasture deficient in phosphorus will chew bones; pigs on rations deficient in lime will root, or if kept in confinement will dig out the lime between the bricks of the pens.

In man, these instincts tend to be blunted by our modern civilization. They are still strong however, in the child. In some recent experiments, infants, instead of being fed only with the usual bland milk foods, were put at meal times in the middle of an assortment of all kinds of foods, including items like meat and raw vegetables, which according to popular opinion can not be digested by infants. They were allowed to dabble among the foods and taste and reject or eat as they pleased. Instead of suffering from indigestion as might have been expected, they grew well and enjoyed exceptionally good health.

In addition to these instincts which man has inherited in common with animals, the human race has acquired empirical experience based on conscious observation and deductive reason. This experience has become embedded in dietary customs and habits. Unfortunately some of it has been distorted with superstitions. Some instances of this acquired experience are of special interest when considered in the light of our know-

1 Summary of a lecture delivered to the Canadian Society of Technical Agriculturists, Guelph, June 23, 1931.
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ledge recently acquired by systematic study. Thus, for example we now know that the administration of iodine prevents endemic goitre and chemists have shown that sponges and certain species of seaweed are very rich in iodine. But before the time of the Greeks it was known that the eating of sponges and certain kinds of seaweed cured or prevented endemic goitre. An even more interesting example occurs in a curious Chinese dietary custom. Recent studies of lactating animals show that there is a loss of calcium and phosphorus during lactation and that the evil effects of the depletion of the mother can be diminished by feeding substances rich in calcium and phosphorus during pregnancy and lactation. In some parts of China pregnant and nursing women eat powdered deer's horns, which are rich in both calcium and phosphorus. Equally interesting are many of the peculiar dietary habits of native tribes in Africa. Earth eating and some of the differences in the dietary habits of men and women are expressions of physiological needs.

Even some of our recently acquired knowledge on vitamins is to some extent a statement in recently coined technical language of previous empirical knowledge. It is difficult to say how long it has been known that fresh fruit and vegetables prevent the onset of scurvy and that citrous fruits have a special antiscorbutic value. The health value of whole wheaten meal as compared with white flour and its special value in keeping the digestive tract in good condition was known long before the term 'Vitamin B' was introduced. The value of cod liver oil for certain conditions of malnutrition and especially for young children was known to our grandmothers and the value for young cattle had been tested by stock farmers in Scotland long before any nutrition research institute was established. Indeed, if we talk of cod liver oil instead of fat soluble A and vitamin D, a good deal of what we regard as recent scientific knowledge on these vitamins, at least that part of it of practical value, has been known for a long time both to the medical practitioner and the stock farmer. This accumulated empirical knowledge has been rather ignored by the scientist. But it is this knowledge acquired by age long experience rather than recently acquired science which still forms the main guide to practice both in the human race and in stock farming.

When we consider how well we are served by our inherited experience of nutrition, we may well ask whether the studies of the biochemist and the physiologists are ever likely to yield any information of real practical value. They will doubtless be of academic interest and may give a scientific explanation to established dietary customs, but will they ever enable us to improve on these customs? This is a question which used sometimes to be put with regard to studies in human nutrition and is still put by some shrewd stock farmers with regard to experimental work on the feeding of farm animals.

The answer to this question, of course, is that modern scientific investigations are merely improvements of the slow empirical methods by which our past knowledge has been accumulated. We now purposely study the subject instead of being dependent on a number of chance similar observations impressing themselves upon us and forcing us to connect

cause and effect. We use instruments of precision to enable us to make exact observations instead of being guided by the memory of general impressions. We purposely coin new technical terms to enable us to give expression to our more exact observations. As a result of this improvement of method, knowledge is now accumulating at a very much faster rate than before the introduction of the scientific method of observation and experimentation.

Let us consider now how our scientific knowledge has developed. The foundation of the modern science was laid by Lavoisier. He showed that heat and muscular work had their origin in a process of oxidation and that the amount of food consumed in the tissues of the individual depend upon the heat produced and the muscular work done. He further showed that consumption of food in the tissues can be measured by the amount of oxygen used up and the amount of carbon dioxide produced and that these can be ascertained by an analysis of the breath. The study of nutrition was now based on chemistry. Hence Lavoisier's famous dictum "Le vie est une fonction chimique".

Having determined the all important part played by oxidation in the animal body, the next advance consisted of determining the oxidisable constituents of food. In the nineteenth century chemists laboriously analysed foodstuffs and animal tissues, classifying the substances found as proteins, carbohydrates and fats. They also determined the amount of energy each could produce when metabolised in the body. The chief credit for this advance belongs to the German chemist Liebig. He devised the new chemical methods necessary for the work, did a great amount of analytical work in his own laboratories, and what was as important, trained and inspired several distinguished pupils who carried on the work in other laboratories.

Liebig gave great prominence to the importance of protein and in the last half of the nineteenth century the chemistry and the metabolism of protein were intensively studied and the proportion of protein which the diet should contain was the subject of much investigation and even more disputation. The protein phase of research may be said to have culminated in the work of Fischer who showed that all the various kinds of protein consisted of different groupings of a small number of comparatively simple bodies, the amino acids, and that these and not the proteins, were the real units in nutrition.

As a result of all these biochemical studies, by the end of the nineteenth century we had obtained a great deal of information on the chemical composition of the body and of foodstuffs. The energy exchange of the body had been determined by calorimetric studies and the material exchanges by balance experiments in which the intake of material in the food and the output in the excreta were determined. At the beginning of the present century it looked as if nutrition had been reduced to an exact science. By the use of chemistry and mathematics diets could be calculated with great accuracy in terms of calories and protein. It was inevitable that at this stage of knowledge the analogy between the body and a machine should be over-emphasized. The function of food

was taken to be to supply fuel for energy exchange and material for construction in growth and for replacement of loss in "wear and tear". Quantity was all important; the bearing of the quality of the food on the health and well-being was rather lost sight of.

It is interesting to note here that at this stage our knowledge of nutrition looked fairly complete and exact. It appeared possible to draw up rations on the basis of the total calories, digestible proteins and inorganic salts, and indeed the diets for human beings and rations for animals were computed on nothing but their caloric value and their protein content, on the assumption that sufficient inorganic salts would be present in any ordinary combination of foodstuffs. We now know that our knowledge at that date was very incomplete. Fortunately in actual practice diets or rations were not based on chemical and mathematical data. People did not make up their meals according to calories and number of grams of protein, nor farmers feed their stock on rations based on tables of starch values and protein ratios. However accurate or complete the science of nutrition might appear it was the inherited knowledge that was still the main guide to practice. People ate according to the dietary customs slightly modified by their individual likes and dislikes, and farmers fed their stocks in the light of their past experience.

The next great advance in the science of nutrition was made in the present century and was due partly to purely academic research and partly to the appearance of malnutrition on diets which satisfied the old biochemical standards. The credit for this modern advance must be shared by a number of workers on both sides of the Atlantic. Probably the chief credit is due to Hopkins of Cambridge. He tested the adequacy of diets by feeding them to animals and he found that a diet might contain proteins, fats, carbohydrates and inorganic salts in sufficient amounts to form what was then considered a complete diet and still be of such a nature that it would not support growth nor maintain health. He consequently came to the conclusion that a diet must contain something in addition to all the substances then known to be necessary.

Comparatively little interest was taken in this epoch-making discovery, but confirmatory evidence was accumulating outside laboratories. The rise of the industrial age with its great cities and the treatment of food by machinery had altered both the dietary habits of the people and changed the nature of the food. The machine treatment of the food in purifying, preserving or cooking in factories, was removing from it some of those substances and properties which are present in the food in its natural state, and are essential for health. As a result, ill health which we now know to be due to malnutrition, began to increase in cities. A specially interesting development of disease occurred in the East Indies where natives given a diet consisting almost excusively of machine milled rice developed a disease called 'beri-beri'. The investigation of this and some other disorders, which we now know to be nutritional in origin, showed that they were due to the absence of substances in the diet. This discovery that there are certain diseases due, not to the presence of some toxic agent, but to the absence of something in the food, stimulated research in nutri-

tion along the lines begun by Hopkins, and during the last twenty years the whole subject has been re-investigated from this new point of view. This research of the present century has shown that foodstuffs in their natural state contain substances, i.e. the vitamins, whose very existence was unknown, and also that some of the inorganic constituents have an importance which was not recognized. It is to this newer and wider field that the main interest in research in nutrition has been directed in the past few years. The results being obtained are of great practical importance, for these food constituents, many of which are required in the merest traces, must be present in the diet in sufficient amount to ensure growth, reproduction and health.

A review of the development of our scientific knowledge of nutrition brings out the fact that research workers have always tended to over-emphasize the importance of the aspect of the subject on which the majority of workers were engaged. We have had the energy requirement phase, the protein phase and the vitamin phase, though of course they all overlapped. We have reached the stage when we are able to take a broader view and consider the diet as a whole. We see now that the energy value, the amount and kind of protein, the minerals and the vitamins are all equally important. A deficiency of any one leads to malnutrition. We recognize that none of the different constituents are of any special value *per se*. It is the proper balance of all the essential constituents which makes a perfect diet. No single constituent can be regarded as a health food in the sense that if added to any ration it will ensure good health. Thus, for example, the addition to a ration of minerals or of a vitamin-rich food like cod liver oil would improve it only if the ration be deficient in the substance added. Indeed, if the ration has already a sufficient amount of what is added, the addition may be positively harmful by upsetting the balance and giving an excess of some constituents which may interfere with the assimilation of some other constituents.

We also recognize the limitations of our knowledge. We have little definite information on the amount of the various essential ingredients of a complete diet necessary for different species of animals at different stages of growth or different levels of production. Nor do we know how a deficiency of one constituent may limit the assimilation of others. We know that in some cases, deficiency of one constituent limits the assimilation of another, but we do not know to what exent this is true of all dietary constituents. It is not even certain that we could make up a complete list of all the substances required to make a complete diet. It is most probable that foodstuffs have substances or properties which are necessary for the welfare of the body, but which we have not yet even begun to study. Indeed, our knowledge is so limited that we have still to fall back upon the old empirical methods of feeding diets to animals and judging whether they are complete or not by their ability to support growth and maintain health. It is obvious that we are only at the beginning of our knowledge of nutrition. There is a great field of research which may yield information not only of value in increasing the output of animal products for human consumption, but also what is even more important, for the prevention

of disease and the general promotion of the bodily welfare of both man and animals.

We have dealt in this lecture with the two great sources of our knowledge of nutrition, viz: our inherited experience and knowledge based on scientific research. In the past the former has been by far the most important. In the circumstances of our modern civilisation however, the second or scientific source is becoming increasingly important. Until comparatively recently, our ancestors lived on locally produced foods to which they had been accustomed for generations and which were used more or less in their natural state. To-day in our cities the choice is lmited to what is available in the shops and much of that has been subjected to treatment by machinery which destroys its health maintaining properties. We have no inherited experience to guide us in the use of white flour, milled rice or tinned foods.

In the case of domestic animals the conditions are even worse. By selective breeding we have produced what are virtually new species of animals. The cow in its natural state gave only about 150 gallons of milk. The ancestor of the hen never laid more than 20-25 eggs in the year. The food requirements of the 1000 gallon cow or the hen laying 250 eggs in the year are totally different from those of their ancestors. Even if their inherited instincts could serve as a guide they have no opportunity of exercising them. We need new knowledge to deal with these totally new food conditions. It is more than a coincidence that this newer knowledge of nutrition has arisen in our generation.

As has been suggested above, it was the appearance of nutritional diseases which has stimulated and directed research in recent times. The results already obtained indicate that this research is of the utmost importance for the welfare of the human race. Already it has been shown that a whole group of deficiency diseases can be prevented by proper feeding and there is reason to believe that even in the case of some of the infectious diseases, the susceptibility to infection depends upon the state of nutrition of the individual. In animal husbandry there are sufficient problems of immediate practical importance to engage us for many years. The whole process of transforming low grade vegetable products which cannot be used directly for human food into valuable animal products like milk, meat and eggs is only beginning to be put on a scientific basis. The food requirements of our modern animals with their enormous capacity for production have not yet been determined. The feeding value of many substances which might be used for animals have not yet been fully examined, and the influence of the feed in maintaining the animals in perfect health with 100 per cent capacity for production and a high resistance to disease, is only beginning to be studied.

In no country in the world is there a greater field for this work than in Canada where, owing to world economic conditions it appears to be necessary to develop animal husbandry and transform some of the grain for which there is difficulty in finding a market, into meat, milk and eggs. In the past, Canadian agricultural research in wheat has been pre-eminent throughout the world. Indeed, the economic results of that research have

created wealth sufficient to maintain and endow agricultural research in Canada for all time. A considerable volume of valuable work on animal nutrition is running at various centres, but it looks as if the time had come to extend this sphere of agricultural research, especially in the direction of bringing all the available scientific knowledge to bear upon the big problems of immediate economic importance to the Dominion.

CURRENT PUBLICATIONS

55. Birth Of Agriculture In Canada. R. P. Gorham. Canadian Geographical Journal, Volume IV, Number I. January, 1932.

Raymond P. Gorham is an Entomologist by profession and a student of the history of Canadian agriculture. A previous note on "The Progress Of Agriculture On A New Brunswick Farm During Four Generations" was published in Scientific Agriculture, Volume V, Number I, September 1924. The present article is of broader scope and the illustrations include Lescarbots' Map of 1609 showing the location of the first water power mill, the remains of a dam constructed in 1606, the "Habitation" of Sieur de Monts, Sieur de Poutrincourt and Samuel de Champlain at Port Royal in 1605 and also a photograph of the memorial tablet placed on the millstone that first ground grain in North America; this tablet was unveiled by Prof. W. P. Sackville on the occasion of the visit of the Canadian Society of Technical Agriculturists to Fort Anne at old Annapolis Royal on June 23rd, 1930. The article refers to the period from 1534-1632.

"When Jacques Cartier first came in contact with the Canadian Indians on the coast of Bay Chaleur in 1534, he found them well supplied with bread although at the time on a fishing expedition far from their usual village. In the following year when he visited Hochelago (later to become the city of Montreal) he saw extensive fields planted with corn and noted also, that they had beans, peas and cucumbers and that they grew and used tobacco . . . . . It is probable also that fall rye was sown, for mention is found in the "Nova Francia" of Marc Lescarbot, who visited the St. Croix in 1606 . . . ."

The feudal tenure of farm land appears in the records of the settlement at LaHave on the southern shore of Nova Scotia in 1632.

"Of particular interest in connection with modern agriculture is the historic record that practically all who pioneered in this field, first learned the principles of Canadian tillage and sowed the seed of which we are now reaping the harvest, were men of superior education and ability."

Mr. Gorham has contributed 17 pages of interesting history and it is hoped that he will expand this record of by-gone days. He writes of the founders, "It seems a fitting thing that their names should be preserved and recorded as the founders of Canadian agriculture". To this unqualified endorsement is given. It is hoped too that research workers located elsewhere will assist in making the record and that the Colleges and Universities may devote more attention to social, economic and "technical" history. This is a responsibility of those engaged in agricultural instruction and research. —J.C.

WOUND-GUM IN PEACHES AND GRAPES

ITS RELATION TO THE INVASION OF FUNGUS WOUND-PARASITES [1]

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Introduction

During his sojourn in Canada, 1925-1927, Dr. L. C. Coleman was engaged in a study of "dead-arm" of grapes, a disease attacking the wood of mature vines and gaining a foothold largely through wounds. Among other things, he observed the hyphae of the causal organism, *Cryptosporella viticola* Shear, in large numbers in the tracheae and other elements of the stem of the host. In some cases, the mycelium was embedded in masses of a yellow gummy substance in the lumina of tracheae. Naturally the questions arose: Is this yellow material wound-gum? Does it occur in uninfected stems? If so, does it act as a barrier to the inroads of the fungus? The present study was begun at Dr. Coleman's suggestion, in an endeavour to answer these questions with regard to "dead-arm".

As it is by no means certain that wound-gum occurs in the cultivated American varieties of the vine, it was deemed advisable, for the purposes of comparison, to make parallel experiments and observations on a woody plant in which wound-gum is known to occur in considerable abundance. The peach, therefore, was selected, partly because the writer had become interested in canker on peach trees, a serious disease in the Niagara Peninsula, and chiefly because this tree, like other stone fruits, is given to copious gum production when injured. For organisms to be used in this phase of the work a *Cytospora* sp. was isolated from cankers and from peach twigs suffering from "Die-back" and *Sclerotinia* sp., Monilia stage, from brown rotted peaches and from incipient cankers.

This investigation, therefore, has as its object the study of wound-gum in these two plants. While some attention is paid to the process of wound-gum formation and to some of the factors conditioning its production, special emphasis is laid on its rôle as a possible natural protection of the wood against invasion by wound-parasites. It is agreed that wound-gum appears in response to a wound, or other injury to the wood of a large number of dicotyledonous (and other) species, with or without the presence of a parastic organism. But opinion is not unanimous as to its origin and little is known of its chemical nature or of the process of its formation. On these points, this paper throws but little light. The question of its effectiveness as a barrier to fungous invasion is also obscure and the scope of the present investigation permits it to lift only a corner of the veil, for the reactions of three organisms on two hosts do not begin to cover the possibilities and probabilities.

[1] A Thesis submitted to the University of Toronto in partial requirement for the degree of Doctor of Philosophy.
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Review of Literature

A stupendous literature has grown up around the subject of gums in plants. Therefore it seems advisable to restrict the present discussion to the two phases of the question most closely related to the paper: first, the substance wide-spread through dicotyledonous woods and designated as "wound-gum", secondly, that associated with gummosis of such plants as plums, cherries, peaches, almonds and apricots.

Early workers, (Karsten, Cramer and others—see Prillieux, (*30*)) believed the gum of cherries to be caused by the transformation of the cell walls. Trécul (*37, 38*) (*30*) was the first to make a careful anatomical study of the gum-lacunae occurring in stone fruits. He considered that the lacunae were caused by an excessive accumulation of food materials in the meristematic tissues and that the gum itself was formed by the disorganisation of both the walls and the contents of the cells concerned. He also distinguished between the gum found in lacunae and that found in the wood (wound-gum). The latter does not swell in water, the former does.

Wigand (*42*) working at about the same time with *Cerasus* (*Prunus*) *avium* agreed with Trécul so far as the lacunae were concerned, but thought that wound-gum was due to the transformation of the cell wall. In his earlier work Frank (*13*) confirmed Wigand in part, but was of the opinion that some of the wound-gum came from the nutrients present.

In 1875, Prillieux (*30*) made an intensive study of gumming in cherries. He was the first to demonstrate that wound-gum is produced from the degradation products of the starch and protoplasm of parenchymatous cells in wood, and oozes out into the vessels by way of the pits. At the same time, he proved that the walls are not altered in structure or composition, as they would be if they contribute to gum formation. He, too, confirmed Trécul, but thought that the most of the gum in the lacunae is formed from the starch and protoplasm of the disintegrating cells.

Böhm (*3*), in his discussion of the function of vessels, stated that wound-gum occludes the vessels, in the zone between living and dead wood, in order to again render the uninjured tissue independent of external air conditions. Frank (*14*), Temme (*36*), Prael (*29*), and Will (*43*), adopting this view and a modification of Prillieux's formulated the hypothesis that wound-gum is the end product of a life-process in living cells and, like tylosis, is a reaction to wounding, with the object of protecting the underlying tissues from injurious external influences, such as air, rain-water and fungi. Frank (*15*) was very careful to point out that R. Hartig (*17*) was entirely in error in thinking wound-gum production an early stage of decay.

Gaunersdorfer (*16*), in the main, agreed with Frank but found that when saprophytic fungi had invaded a wound, the browning was more extensive. He, therefore, doubted that wound-gum was a protection against fungi. Prael, Gaunersdorfer and others came to the conclusion that the normal heartwood is identical with the heartwood formed in neighborhood of wounds.

Von Tubeuf (*39*) also thought that wound-gum is produced by living cells, and that it affords protection only against those fungi which can live only in living cells, otherwise wood impregnated with wound-gum is favourable to the spread of fungus. He found that *Cucurbitaria Laburni* was able to thrive in the brown wood of *Cytisus Laburnum*.

Hartig and Weber (*19*), Hermann (*21*) and Tuzson (*41*) found, in red beech, which does not produce a normal heartwood, a false heartwood caused by air and fungus in vicinity of wounds and characterized by wound-gum in its various elements. Hermann and Tuzson considered it as a protection against fungus invasion, on the grounds that tyloses and wound-gum cut fungi off from supply of air and moisture, retarding their progress. This protection seems rather ineffective for, Hermann added, tyloses and gum formation ultimately are dissolved by the penetrating fungal hyphae.

Lindroth (*24*) considered that false heartwood of birch arises as the result of the combined activities of fungus and oxygen and affords a certain amount of protection to the tree.

Münch (*28*) gave a comprehensive survey of the literature to date and by his careful research came to a totally different conclusion from Frank. "Dieser Stoff ist kein Sekret lebender Zellen; er entsteht erst nach dem Absterben der Zellen und zwar als Oxydationsprodukt des Zellinhalts, vielleicht auch daneben einzelner Bestandteile der Zellwand oder des Holzsaftes. Insofern ist das gebräunte Schutzholz das erstes Zersetzungstadium des toten Holzes, wie Hartig früher richtig behauptet hatte". This conclusion was based on plasmolytic tests of cells engaged in wound-gum production on the border between living and dead wood.

He is of the opinion that any benefit the plant derives from wound-gum-impregnated wood, so far as protection against external factors, such as air and moisture, is concerned, is a question of an "accidently useful secondary effect of an otherwise harmful decay".

With regard to the relation of heartwood to fungal attack, he says: "Nun braucht Verkernung (pathologische oder normale) zwar keinen direkten, absolut antiseptischen Schutz gegen Pilzfäden zu beiten. Von Tubeuf hat an *Cytisus* (*39*) beobachtet und nachdrücklich hervorgehoben, dass verkernte Holzteile von Pilzfäden leicht durchbohrt werden. Die Verstopfung der Gefässe bietet aber sowohl dem verkernten Holz als namentlich auch dem hinterliegende, gesunden Holz die Möglichkeit sich relativ luftarm zu erhalten, den Luftwechsel zu verhindern und so schon dadurch den Pilzfäden das Gedeihen und ihre zersetzende Wirkung zu erschweren. Möglicherweise wirken auch die gebräunten Zersetzungsprodukte der Zellinhaltsstoffe, mit denen die Zellwande durchtränkt sind, bis zu einem gewissen Grade direkt pilzschädlich oder sind wenigstens schwerer aufnehmbar als es die noch nicht oxydierten Zellbestandteile wären. Jedenfalls ist im Endeffekt Kernholz (normales und auch pathologisches) resistenter gegen Pilze als Splint. Wenn im stehenden Baum der Splint weniger angegriffen wird als der Kern (was so oft zum "hohlen Baum" führt), so rührt dies, wie wir heute wessen, nur von der Sauerstoffarmut des Splintes infolge seines Wasserreichtums u. s. w. her. Sobald dieser Unterscheid aufgehoben wird, wie im gefällten Holz, wird der Splint sehr viel rascher zersetzt als Kern".

With regard to this last point, it seems to me rather that *living* sapwood is more resistant to fungus attack than heartwood, but heartwood is not decayed so quickly as *dead* sapwood or unimpregnated wood. That is to say, in standing trees, the resistance of sapwood to decay is more dependent on its vitality than on its poverty of oxygen.

In recent years, Rhoads (*31*), Higgins (*22*), Coster (*12*), and Swarbrick (*34, 35*) have made contributions to the subject of wound-gum production. Rhoads surveyed the literature thoroughly and from his own observations and experiments, arrived at these important conclusions:

1. The black zones between healthy and dead tissue may be destroyed by wood-decaying fungi and constantly renewed in the wood on the borders of decay;

2. The formation of wound-gum depends on the presence of dead cells, an optimum supply of moisture and a supply of oxygen sufficient to promote oxidation;

3. By the action of strong oxidising agents on fresh sapwood, a brown decomposition product may be prepared, essentially like that occurring naturally in wood. (He showed that the action of hydrochloric acid and potassium chlorate either on sapwood or on wound-gum yields an alcohol-soluble reddish brown substance, while wound-gum itself is insoluble in alcohol. This would indicate the possibility that in wound-gum production oxidation has proceeded only to some intermediate stage. Thus the above conclusion is not altogether justified.)

Higgins demonstrated that wound-gum is formed when poisons are applied to wood in concentrations slightly below that required to *fix* the living cells. He found that it could be produced in boiled pieces of wood. He, too, favoured the idea of the protective role of the gum. Strange to say, though he described both the gum formed in lacunae, or gum pockets, and that formed in wood, without distintegration of tissue, he failed to distinguish between them.

Coster found no wound-gum production in pieces of teak wood heated to 100°C (presumably in dry heat). He was of the opinion that in teak, at least, "heartwood" and "wound-wood" are not identical, the former containing a resinous substance resulting from the vital process in senescent or dying wood, the latter, wound-gum, caused by the action of enzymes in adequate moisture in dead wood.

Swarbrick reported a difference in the quantity of wound-gum produced in different seasons of the year. He suggested that the plugging of vessels by wound-gum is a response to wounds in woody tissue similar in purpose and nature to the closure of a wound in parenchymatous tissue by suberization. In a second paper (*35*) he showed that, a smaller amount of tissue is affected and less damage done when apple shoots are ringed after bud-break, even though (or perhaps because) wound-gum is produced more copiously and rapidly then than in winter or early spring.

With regard to gummosis and the production of gum in gum-pockets, mention should be made of the papers by Beijerinck and Rand (*2*), Mikosch (*26*), Ruhland (*32*), Butler (*10*), and Sorauer (*33*). But it is aside from the main purpose of the paper to discuss them here.

In connection with relation of wound-gum to fungal invasion Briton-Jones (*4*) suggested that *Cytospora* and *Diaporthe* cannot readily penetrate gum, which is therefore probably a deterrent to fungous invasion and that gum is formed as a reaction of the host to the presence of hyphae or to toxic substances produced by the fungus and carried by way of the vessels. Brooks

and Bartlett (*5*) observed hyphae of *Cytosporina Ribis* penetrating wound-gum in all directions. Brooks and Storey (*6*) correlated resistance of plum trees to *Stereum purpureum* with ability of host to produce large quantities of gum, though they found that the presence of this fungus was accompanied by browning and wound-gum production. On these (and other) grounds, they reported wound-gum as only partially protective.

The "Healing" of the Grape Wounds

As pruning wounds are by far the most common form of injury to grape vines, the study of wounds, in this investigation, was more or less limited to the process of "healing" in stubs, many of which were made in the regular prunings of 1928 and 1929. It is doubtful if the term "healing" is justifiable in this connection, because the stubs rarely become overgrown with callus and until that happens the wound cannot be considered as healed. Strictly speaking, then, the process under discussion is one of death rather than of healing. Throughout this paper, the term "stub" is applied to those pruning wounds in which more or less of the pruned branch is left as a projection.

If a stub is made during the dormant period, and therefore when enzyme activity is at low ebb, the exposed outer end of the stub dries out before the starch is changed very much. In consequence, a zone later develops there, from one-sixteenth to three eighths of an inch deep, in which there is both an abundance of starch and considerable browning; for sake of convenience this is referred to as zone "A". When stubs are made in the summer months, during the period of active growth, the "A" zone is much smaller, having a depth of about one-thirty-second of an inch. Below this a second region, the "B" zone, sooner or later appears. The "B" zone is characterized by its darker brown colour and the absence of starch. In the September-cut stubs it made its appearance before the winter set in, but in February stubs, it did not appear until growth was resumed in the spring, for, when the latter were examined in June its presence was indicated by a thin line, in a longitudinal section, and by August it was a little more than one-thirty-second of an inch thick. The brown coloration, in both regions, is due, in small part, to the darkening of the cell walls, and, for the most part, to the presence of brown and yellow material (wound-gum), partly as globules and partly as larger irregular masses, in the wood-parenchyma, fibres and medullary ray cells.

Next to the "B" zone lies a green, starchless portion (the "C" zone) which in the course of the summer gradually increases inwards until it reaches the base of the stub. The brown region "B" at the same time is also extending down the stub, encroaching on the "C" zone, so that, in almost a year, "C" has disappeared and the stub is brown and dead, almost, if not quite to the base. Thus it would appear that the disappearance of starch from the stub is the forerunner of death. It should be noted that the process of dying is much slower in grape stubs than in peach stubs. For example, in seven months, in peach, starch is transformed into wound-gum to a depth of at least three inches. On the other hand, in the grape, during the same period, starch has disappeared to a depth of well over an inch but is transformed into wound-gum for less than a quarter

of an inch. Tyloses are very often found in these stubs. But, as they are present in the older wood when the stub is made and do not appear in the younger wood afterwards, they cannot be considered here as a response to wounding.

Although there is a considerable quantity of wound-gum produced in the medullary rays and parenchyma cells as the stub dies, there seems to be little or no migration of it into the vessels. It is reasonable,therefore, to suggest that the absence of the typical, yellow, wound-gum plugs from vessels in dead areas of grape wood is due, in part, to the fact that the vessels already contain a more or less solid substance. When an arm or shoot is removed, the wound "bleeds" more or less, according to the time of year in which it is made. But, after a time, evaporation or oxidative processes, or both, bring about a jellification of the sap, with the result that the end of the stub becomes covered with a mass of hard, brown material. This is present even on most stubs of the February pruning, so that it is obvious that a certain amount of "bleeding" occurs either at the time of cutting, or most likely, when the vine resumes growth in the spring. The jellification, however, is not restricted to the surface of the stub but proceeds for some distance down the tracheae, usually to the base of the stub at least. This statement is based on the frequent observation of a colourless jelly in the tracheae of sections freshly mounted in iodine-chloral-hydrate, or in water. There is further evidence for this in that stubs placed for some time in water or in formal-acetic-alcohol extrude filaments of the jelly from the exposed ends of tracheae. This extrusion is due to the power of the gel to imbibe water and thereby swell—a reaction marking it as distinct from wound-gum which does not swell in water.

The slow rate of dying mentioned above is indicative of the slow autolysis of the parenchyma cells. For this reason, it is probable that wound-gum is not produced in sufficient quantity to force it out into vessels already more or less filled.

Yellow material is sometimes observed in the tracheae, however, but it is always associated with mycelium. The origin of this yellow substance is doubtful. But from the evidence brought forward above, there is as much reason for believing that it is the result of the action of the fungus on the jelly, as there is for believing it to be true wound-gum. In any case, since the tracheae of uninfected stubs are free from wound-gum plugs they cannot be a factor in hindering or preventing infection by wound-parasites.

There is considerable difference among the varieties of grapes grown in Ontario with regard to their susceptibility to "dead arm". According to the findings of Coleman (*11*) Niagara is the most resistant, though it is by no means immune, while Concord, Worden and Lindley are highly susceptible. It was thought that the difference in susceptibility among these varieties might be correlated definitely with differences in wound-gum production. With this in mind, careful comparisons were made between stubs taken from the varieties named above, at intervals during the summer of 1928, and again in the early part of the summer of 1929. However, there was no appreciable difference between the brown zones, in comparable stubs, with regard either to quantity of brown material present, or to the rate at which they increased in size. In none of the stubs ex-

amined were wound-gum plugs found in the vessels. Comparisons made on July 5, 1929, of two February-cut stubs each, of Niagara, Concord and Worden showed a close similarity in the "A" and "B" zones (see above) but the "C" zone in Concord and Niagara was much narrower than in Worden. This difference does not coincide with the respective susceptibility of the varieties. Consequently we are forced to conclude that the varietal resistance and susceptibility of grapes to the "dead-arm" organism (*Cryptosporella viticola*) must be due to factors other than wound-gum.

The "Healing" of Wounds on Peach Trees

"Healing" in the growing season.

On July 31, 1929, several series of wounds were made on two to four year old branches of old peach trees on the farm of the Dominion Laboratory of Plant Pathology, St. Catharines. The series included heating with the flame of an alcohol lamp for one minute, ringing with and without injury to the cambium, slitting the bark longitudinally and pruning to stubs. Half of each set of injuries, with the exception of those due to heating, were covered with grafting-wax as soon as they were made. This was done to discover the effect of the exclusion of air and the reduction of water loss from the wounds on wound-gum formation and on healing. At intervals of two weeks, specimens of each set were brought into the laboratory and carefully examined.

In the first series the branches were heated only on one side at one point but in less than two weeks they became completely girdled by a ring of sunken dead bark, wider above the heated area. With the exception of a small zone immediately beneath the point of application of heat, the starch disappeared fairly rapidly and completely from the wood to the distal end of the branch, and more slowly for a few inches below the wound. The starch disappearance from the wound upwards was accompanied or closely followed by the appearance of yellowish globules in the medullary ray and parenchyma cells. Later the vessels became occluded by wound-gum, usually in the form of double-concave plugs. Wound-gum also formed for a short distance below the wound. In four weeks the branches were completely defoliated above the injury. While in seven weeks pycnidia of *Cytospora,* containing immature spores, were plentiful in the neighbourhood of the wound. Considerable mycelium was present in all tissues of the wood and extended for some distance below the border of the lesion.

Shallow injuries, affecting the bark only, were rapidly healed. The exposed tissue to a thickness of about ten cells from the wound had dried out and died so rapidly that the starch remained in it practically unchanged. Beneath this, in a zone five to eight cells thick, the cells had died more slowly, so that the starch had disappeared to be replaced by yellow masses resembling wound-gum. Deeper still, the starch had also gone but the cells had resumed active growth and developed a periderm which completely segregated the injured tissue (figure 18). The inner layers of the yellow zone and the outer ones of the periderm were lignified. All these phenomena took place in less than two weeks after wounding. Subsequently the outer layers of the periderm became suberised and brown

and starch reappeared in the tissue beneath. In the covered wounds the two outer regions were much less extensive (figure 17), the periderm was thicker and starch had disappeared from a smaller area. In all cases, the wood beneath the wound remained unaffected.

Where both cambium and wood were injured, the phloem and cortex were healed in the manner just described, but in this case sundry changes occurred in the wood also. Beneath the wound and for a short distance above and below, the starch disappeared from the wood, almost to the pith. In two weeks wound-gum was present only in the outer exposed layers of wood, and towards the borders of the wound-gum region the plugs were lignified. At the same time, callus began to develop from the cambium and phloem parenchyma. In this connection, it is of interest to note that in uncovered ringed branches the callus formed first and most abundantly from the *upper* side of the ring but, when the rings were covered with grafting-wax, the callus grew almost equally from *both* sides of the ring. Callus formation, too, was much more rapid in covered wounds. After the wounds became closed wound-gum formation ceased and starch was redeposited in the living wood. The wound-gum region was always thicker where callus overgrowth was not complete. In these wounds, another interesting phenomenon was observed. A series of gum pockets, formed by the dissolution of some of the cambial cells, (figures 19, 20, 21) appeared in the position occupied by the cambium at the time of wounding. If the wound healed successfully, the gum-pockets became enclosed by layers of wood laid down later. It is significant that neither gum-pockets nor new wood were formed *below* uncovered rings until after four weeks, that is until cambial activity was resumed there. On the other hand, both gum-pockets and new wood were observed in two weeks *below* covered rings. Covering wounds with grafting-wax seems to favour callus formation and reduce damage due to drying but does not prevent the formation of wound-gum.

In the case of stubs, even when covered, healing scarcely went beyond an abortive attempt at both periderm and callus formation. The starch vanished from the wood as far as the base of the stub and was gradually replaced by wound-gum which appeared first in the parenchymatous and medullary tissue and then in the vessels as already described. Thus, in three or four weeks the vessels of the stub were occluded to such an extent that water could not be drawn through them.

"Healing" in the dormant season.

For purposes of comparison, a series of wounds similar to those just outlined, was made on February 24, 1930. At that time, there was little or no starch in the phloem but an abundance in the xylem. Judging by the appearance and quantity of starch throughout the parenchyma system of the wood, it had not yet begun to be utilised. As late as April 9 the cambium had not yet resumed its activity, since it was very difficult to separate the bark from the wood.

In contrast to the corresponding injuries of July, there was, after six weeks, only a small area of sunken dead bark, where the flame was applied. Subjacent to the dead bark, the wood had been killed half way to the

pith. In this killed wood, the starch was still present and more or less coagulated by the heat. A thin, light brown zone, increasing with time, in the direction of healthy wood, delimited the dead region. In this brown zone the starch was partially replaced by characteristic yellow and colourless globules in the parenchymatous tissue and a very few colourless occlusions appeared in the vessels, prior to bud-break. Later the wound-gum region spread as deep as the pith in a sector, at the cambium slightly wider than the original injury. Longitudinally it extended somewhat further above than below the edge of the lesion. Gum formed in abundance and exuded over the surface of the wound. Unlike the branches heated in summer, these remained alive and a callus grew partly over the wound.

In the shallow bark wounds, periderm formation was not initiated until after active growth recommenced in the spring. Consequently, the tissue, where not covered, dried out and died, almost, if not quite, to the cambium. Where the cambium became damaged, wound-gum was produced in the wood, but not otherwise. The outer cells of the dead region were filled with brown masses of wound-gum, the inner ones with yellow. As starch was absent from the phloem, none was observed in the dead tissue. If the wounds were covered with grafting wax, much less damage was done and none of the dead cells contained the brown material. Where wood was involved in wounds it became slightly brown where exposed and lost only a small quantity of starch. Yellowish globules were present in the medullary ray cells of the brown region but little or no wound-gum was seen in the vessels and no gum-pockets or callus appeared before blossom time. Afterwards, gum-pockets, callus and wound-gum rapidly formed. Owing to the longer exposure before healing began, the wound-gum region was more extensive in winter wounds, especially those not protected by grafting wax.

The brown region in the wood at the ends of stubs extended much deeper than in lateral wounds. This is apparently due to the fact that in transverse cuts the exposure of vessels facilitates the drying process. When browning and death of wood occurs during the dormant period, there is only a partial disappearance of starch. When it occurs during the period of active growth, starch disappearance is total. So that in winter wounds, the outer dead wood contains much starch and relatively little wound-gum and the inner no starch and an abundance of gum.

Discussion.

It is interesting to note the differences in the reaction of branches to wounding at different times of the year. Those phases of healing, such as callus and periderm formation, connected with the active growth and division of cells commence very soon after wounding during spring and summer months. But, if the wounds are made in the dormant period, they do not appear until after active growth is resumed. This is important, for it means that if a tree is wounded during the late fall and winter, healing is delayed till spring. In the meantime, the tissues in the vicinity of the wound are gradually dying, and a superficial injury may assume greater significance. It is noteworthy, that, in wounds made on February 24, 1930, there were no signs of the formation of gum-pockets,

when examination was made six weeks later. On the other hand, in summer wounds, they were well developed within two weeks. This method of gum production is associated more with cell activity than with autolysis, at least in its early stages, since the lacunae are formed in active cambium, at, or soon after injury. After a time, the cambium often resumes its normal function and the gum-pockets become overgrown with normal wood or phloem. Similar series of embedded gum-lacunae are frequently found in nature and are considered to be due to disturbances in the cambium, brought about by frost, mechanical injury or some other shock.

The lacunae are, in cross-section, circular or elliptical with the longer axis radial. In longitudinal section, they are usually, but not always, longer than wide. They nearly always contain loose-lying parenchyma-like cells, free from starch, and, at the edges, partly dissociated cells, (figures 19, 20 and 21). The cavities are full of gum, the quantity of which is much out of proportion to the amount of material that could reasonably be expected to come from the dissolution of the middle lamellae of the cells involved. The fact that the cells in, or adjacent to the pocket are free of starch is highly suggestive of the origin of part of the gum. The gum in embedded lacunae frequently becomes impregnated with lignin, sometimes throughout, sometimes only in the margin, and sometimes not at all.

The other phase, preceeding or accompanying healing, namely, the occlusion of tracheae by means of wound-gum, also takes place rapidly in the summer months. In contrast to the method of gum-formation previously discussed, wound-gum production is associated with the death and autolytic breakdown, but not dissolution, of parenchymatous cells in general. The outermost layer of cells in wounded phloem or xylem dry out very quickly and thus are killed before the starch can be removed from them. This starch-filled, dead, brown region is larger and more noticeable if the wound is made during the winter months when the wound is exposed to drying conditions for a long period and when the temperature is so low that enzymatic activity is more or less inhibited. Beneath this zone, the cells die more slowly and, protected by the dead cells, do not lose their moisture entirely, or, at least, rapidly. Here, the starch is dissolved and replaced by either colourless or yellowish globules, which react positively to Sudan III, the test for fats (figure 1). Less than two weeks after wounding, in mid-summer, the globules may be seen issuing into the tracheae by way of the pits in the tracheal wall. At this stage, small globules overlying pits are frequently observed in vessels (figures 2 and 3). Several writers, Sorauer, Münch and others, have demonstrated an accumulation of food in the vicinity of a wound. The vigorous cell activity concerned with callus formation in all wounds, with the exception of stubs, is good evidence of this. Much of the food accumulated, however, seems to be used up in autolysis for, in this case also, the amount of gum formed appears to be out of proportion to the quantity of food originally present. This is especially true in the borders of wound-gum formation. However that may be, the drops in the vessels increase enormously in size, fuse and eventually completely occlude the lumina. The plugs vary in thickness from a few to several hundred

microns. In the early stages, here and there drops and plugs in the vessels are stainable in Sudan III, but the majority are no longer of a fatty nature. Many are colourless at first, but in old established wound-gum regions they are all yellow to brown in colour.

Lignification of the wound-gum plugs is somewhat erratic. In a large wound-gum region, the majority are unlignified but occasionally some are completely lignified, while others are lignified only in part. However, where the wound-gum region is in contact with living tissue, the occlusions are usually impregnated with lignin. The observation "wound-gum lignified near the pith and bark and at the borders of the wound-gum region" occurred frequently in my notes on the examination of stubs, inoculated and otherwise. The lignification of wound-gum near the pith may be explained by the fact that branches are very often brown at the centre when freshly cut. They, therefore, contained wound-gum before the wound was made and at the time of formation, the lignified plugs were adjacent to living tissue. The lignification of the plugs near the bark and at the borders of the region took place after the wound.

During the dormant season, browned areas, in the initial stages of wound-gum formation, and some starch disappearance are to be observed. In the browned areas, there are the typical colourless and yellow globules in the medullary ray and parenchyma cells, but few, if any, plugs in the vessels. A perusal of weather records shows that the air temperature on many days in late autumn, in early spring and even in winter is considerably above freezing. Thus, though the tree is still in the dormant condition and no new tissues are being formed, dead (or dying) cells are still capable of autolysis, when temperature conditions permit. The disappearance of starch from the phloem in late February and early March, is further evidence of enzymic activity at that time of year. Autolysis and enzyme action are naturally slow at the temperatures then prevailing and the translocation of food material is practically nil. Consequently though wound-gum formation can proceed slowly then, plugs are not formed, or, if so, are not produced in any appreciable quantity. Therefore it is tenable that, during the dormant season, wound-gum production is limited more by temperature than by the dormancy of the tree.

That atmospheric oxygen, in quantity at least, is not necessary for the production of wound-gum is supported by the evidence briefly summarized below. First, covering wounds with grafting wax protects tissue from contact with air, but does not prevent the formation of wound-gum. Secondly, plugs of wound-gum are present near the pith in branches not injured at the surface. Lastly, there is a continued production of wound-gum in the deeper tissues in stubs and in the neighbourhood of cankers after contact with the atmosphere is cut off by the plugging of intervening tissue.

Wound-gum Formation in Blocks of Wood

To discover, if possible, the effect of various conditions on wound-gum formation, a modification of Coster's experiment (*12*) was carried out. One year old branches of peach and one and two year old shoots of grape were brought into the laboratory and cut up into blocks about three-

quarters of an inch long. Part of these were not subjected to further treatment; part were heated for an hour and a half at 180° C.; the remainder were kept at 45°-47° C. for eighteen hours, in an attempt to kill the tissue without destroying the enzymes. Some of each lot were placed in a desiccator, over calcium chloride, some in a moist chamber and the others in a moist chamber to which toluol was added, to keep down fungi and to hasten the death of the untreated blocks. Fungi were observed only in the blocks in the moist chamber without toluol.

The results of the experiment are briefly recorded in tables 1 and 2.

TABLE 1.—*Observations on blocks of peach wood variously treated.*

	In desiccator over $CaCl_2$			In moist chamber		In moist chamber with toluol	
	Days	Starch	wound-gum*	Starch	wound-gum*	Starch	wound-gum*
Untreated blocks	8	3	1	1	3P	3	1
	23	2	2P	(0) (2)	(4P) (2P)	2	2P
Blocks heated 18 hrs. at 45-47..C.	8	2	2	3	2	3	1
	23	2	2	2	2	2	2
Blocks heated 1½ hrs. at 180.. C.	8	3	1	3	1	2	2
	23	3	1	3	1	2	2

*The yellow decomposition products in parenchymatous cells.
(0: absent; 1: present, but less than half; 2: about half; 3: more than half; 4: present throughout; P: wound-gum plugs in vessels.)

It is significant that wound-gum in sufficient quantity to occlude vessels, was formed in the untreated blocks only, and in all containers. In the desiccator a few plugs were formed at the ends of the blocks where death occurred during the drying process. Presumably the inner tissues did not succumb until there was insufficient moisture present for starch digestion and for wound-gum production in quantity. In the moist chambers, the blocks which died had produced wound-gum, more or less throughout.

In the heated blocks, the initial stages of wound-gum formation began, as indicated by the occurrence of yellow droplets in the medullary ray cells. This may well have happened during the killing process. Certainly very little wound-gum was formed afterwards since there were no plugs in the tracheae. These observations confirm those of Münch (*28*) who states that if poplar twigs are killed by rapid drying no wound-gum is produced, even if the twigs are moistened again later.

The starch situation in the blocks killed at the higher temperature is rather puzzling. It is possible that the heat penetrated the wood slowly so that the starch disappeared rapidly while the amylase enjoyed optimum temperature conditions before the thermal inactivation point was reached. This suggestion gains some weight from the fact that the starch was gone from the *interior* of the blocks in the desiccator and in the moist

chamber with toluol. In the other moist chamber, the activities of fungi are sufficient to account for the absence of starch from the outer parts of the blocks. It is interesting to compare these blocks with the heated wounds. There, only the wood directly beneath the flame was heated to the point where death and drying occurred before the starch was removed. The remainder of the branch at that level was evidently heated enough to kill the cells, but not enough to destroy the enzymes, because wound-gum was formed copiously there. While the distal portion of the branch was killed by a gradual drying, after the water supply had been cut off by the occlusion of the vessels near the wound.

TABLE 2.—*Observations on blocks of grape wood variously treated.*

			In desiccator over $CaCl_2$		In moist chamber		In moist chamber with toluol	
	Age of blocks	Days	Starch	wound-gum*	Starch	wound-gum*	Starch	wound-gum*
Untreated blocks	Current season	8	0	3	0	3	2	2
	2 year	8	3	1	1	3	3	1
		23	3	1	1	3	2	1
Blocks heated 18 hrs. at 45.. to 47.. C.	Current season	8	2	1	–	–	2	2
	2 year	8	3	1	2	1	3	1
		23	3	1	2	1	3	1
Blocks heated 1½ hrs. at 180.. C.	2 year	8	2	2	2	2	1	2
		23	2	2	2	2	1	2

*The yellow decomposition products in parenchymatous cells.
(O: absent; 1: present, but less than half; 2: about half; 3: more than half; 4: present throughout; P: wound-gum plugs in vessels.)

The blocks cut from current season grape wood seemed to lose their starch much more quickly than did those from two-year shoots. The untreated blocks underwent more or less autolysis, especially in the moist chambers, with the result that a certain amount of yellow decomposition-product appeared in the medullary ray cells. It is probable that changes from starch to yellow material occurred, both during and after heating, in the blocks killed at the lower temperature, but in the blocks killed at 180°C, it was practically impossible for autolysis to take place after heating as they were then somewhat charred. It should be noted, however, that plugs of wound-gum did not appear, even in the untreated material (cf. peach wood).

From these experiments it is evident (1) that as wound-gum appears starch disappears, (2) that a certain amount of moisture is requisite for the transformation of starch into wound-gum, (3) that this change may proceed independently of fungi, (4) that heating and drying prevents the completion of the process, (5) that the occlusion of tracheae by

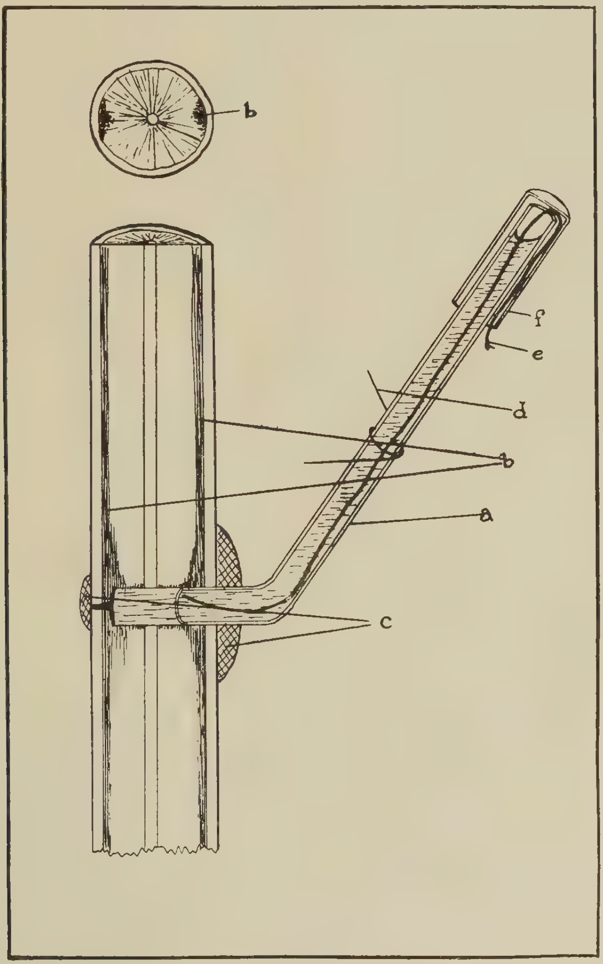
wound-gum is characteristic of peach wood but not of grape, and (6) that in the grape, the early stages of wound-gum formation do occur, viz., the yelllow decomposition products in dead parenchyma.

Effects of Fungal Extracts, Etc., on Wood

On Grape Wood.

Late in August, 1928, a series of injections was made in grape vines by means of the apparatus illustrated in text figure 1. This apparatus is a modification of that employed by Brooks and Moore (*8*) for the injection of plum wood.

The holes, into which the glass tubes fitted snugly, were made so that the point of the auger just emerged on the opposite side of the arm. This was done in order that the young wood at each end of the hole could



Text figure 1: Apparatus used for injecting liquids into grape vine. a, bent glass tube, long arm about one foot long; b, course taken by injected liquid; c, grafting wax; d, wire brace to support (a); e, wire to remove entrapped bubbles; f, small phial to reduce evaporation.

be available for the conduction of the injected fluids. After the insertion of the glass tube, the hole was made water-tight by means of grafting wax. Bubbles were removed from the cavity by suction after the tube had been about a quarter filled with liquid. The tube was then filled and covered with a small phial.

An extract was made by macerating two previously frozen *Cryptosporella* cultures in 50 c.c. of water, and filtering through a Chamberland candle to remove mycelium and spores. This extract was made up to 100 c.c. and tinted with .05 per cent eosin. For comparison a .05 per cent solution of eosin in sterile distilled water was used.

One of the injected branches absorbed in the neighborhood of 40 c.c. of extract, the rest from 5 to 12 c.c. The course of the injected fluid in young wood could be traced for several inches up and down and in some cases into smaller shoots six or seven inches distant. After a few days the cavities became filled with the jelly-like substance so often found in the vessels in stubs, causing the rate of absorption to decrease considerably.

Histological examination revealed the presence of yellowish masses in many medullary ray cells in the region injected both with distilled water and with fungal extract. The amount of browning became less the further removed it was from the point of injection, and was somewhat more pronounced with the extracts of *Cryptosporella*. That the disturbance was due to the injection and not to the wound stimulus is shown by the fact that, in a preliminary series, where injection failed, browning occurred for not more than one sixteenth of an inch from the boring.

These experiments do not establish the toxicity of the fungal extract, which was very dilute. But they do show that browning of the wood can be brought about by the introduction of substances detrimental to living cells. It is unfortunate that lack of time prevented a repetition of the experiment on a more comprehensive scale.

On Peach Wood.

The fact that wound-gum formation precedes the advance of *Cytospora* in cankers, and also that the wound-gum region extends more rapidly in a longitudinal direction, seems to indicate that some toxic substance is excreted or secreted by the fungus and carried along the stem either by diffusion or by the water transfer. McCubbin (*25*) has shown that a toxic substance, produced by *Sclerotinia* is able to induce gum in peach wood. An experiment, therefore, was planned to attempt to discover the effects of extracts of *Cytospora* on peach wood. Five flasks were arranged to contain:

A. An aqueous extract of *Cytospora*. Three old tube cultures of *Cytospora* were filled with tap water and allowed to stand for about 21 hours. They were then macerated thoroughly, filtered to remove spores and diluted to 100 c.c.

B. An aqueous extract of *Cytospora*, treated with Acetone. Three cultures of Cytospora, of the same age as in A, were cut up into small pieces and dropped into 250 c.c. acetone. After drying, the cultures were extracted with water for 16 hours, and macerated, filtered and

Text figure 2: Peach twigs, showing bud development; A and B in extract of *Cytospora;* C in tap water; D in distilled water; E in extract of potato dextrose agar.

made up to 100 c.c. as in A. No spores were observed in the filtered extracts.

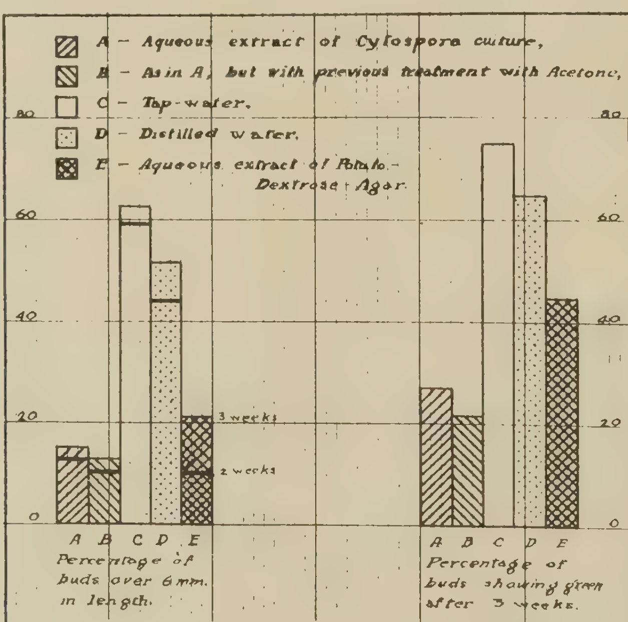
C. 100 c.c. of tap water.

D. 100 c.c. of distilled water.

E. 100 c.c. of extract of sterile potato dextrose agar, prepared as in A.

Resting peach twigs, free from browning were brought in and their proximal ends cut under water. Four of these twigs were then put into each flask and the whole experiment was transferred to the greenhouse. Text figure 2 shows two representative twigs from each flask, 25 days after the experiment was begun.

In all, most of the buds began to swell and show green within ten days. But after that, in A and B, the buds on the part of the twig protruding from the flask, began to die and at the time the photograph was taken the twigs were dry and dead almost down to the top of the flask. Strange to say, the buds inside the flask continued to grow fairly well. In C, D and E there was no dying at the ends. The buds in E did not develop so well as those in C and D, but were still alive four weeks after the beginning of the experiment. The graphs (text figure 3) show very clearly the effects of the different liquids on bud growth.



Text figure 3: Graphs illustrating effect of fungal extracts, water and extract of potato dextrose agar on the development of peach buds.

After one week a twig from each was examined. In A and B the cut end was brown to a depth of .5 to 1.0 mm. with an abundance of starch in brown region. Starch was plentiful in rest of twig except for a centimeter or two above the brown part. In C and D the starch was going uniformly throughout the twig, even to the cut end. Browning

had not occurred to an appreciable depth. E seemed to be intermediate between A and C.

After three weeks, twigs in A and B had lost all starch except for a millimeter or so at cut end. Wound-gum plugs were fairly abundant in dead wood and colourless globules and plugs were present even in some of the vessels of the wood still white and apparently alive. In C and D there was little or no starch left in the wood even at the cut end. Some colourless wound-gum globules and plugs were present near pith, somewhat more abundant in D than in C, but not so plentiful in either as in A or B. E again occupied an intermediate position so far as the wound-gum plugs were concerned. More or less cambial activity had taken place in all twigs.

At the end of six weeks, the twigs in both the *Cytospora* extracts were dead, nearly all the leaves had fallen, and the remaining ones were yellow. Upon examination it was found that the wood was *brown* throughout, and more or less filled with wound-gum plugs. In marked contrast, the twigs in water, both C and D still retained their leaves, which, though somewhat wilted, were green. The wilting was due to the plugging of the vessels for about an inch from the cut end. Except for this, the wood was white and almost without plugs. In E, the buds were not fully expanded, but were still alive and had grown since the last examination. The wood was white and living and contained little wound-gum even at the cut end.

It is evident, therefore, that the fungal extract exerted a harmful effect on the twigs, eventually killing them. At all events, some substance present in the extract induced wound-gum formation. Thus it seems quite probable that, in the host, these substances are secreted or excreted by the fungus and are capable of killing the tissue surrounding the infected region. This offers one explanation of the extent of the browned wood in a lesion beyond the limits of *Cytospora*. The curious behaviour of the buds in A and B and the death of the distal part of the twigs in the early stages of the experiment may be attributed to the cumulative effect of the plugs then present in the wood. These would permit considerable water to flow some distance up the twigs and be available to the lower buds. At the same time, they would prevent the access of water to the distal part of the twig in sufficient quantity for the development of buds. Moisture conditions inside the flasks would also tend to keep buds alive there for some time.

(To be continued in the next issue)

USE OF ECONOMIC INFORMATION IN EXTENSION WORK[1]

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The subject assigned to me is not the question of obtaining economic material for extension work or even the availability of such material. This was in part touched on in a paper given at the group meeting a year ago. However, in extension work it is often not the economic material that we would like which is used, but that which is readily available. As extension work is developed the need of additional economic information is realized and as a result further data are demanded. In fact, the growth of agricultural economics has to a considerable extent been furnished as demanded by the producers. The fact that much of our research work and much of our earlier work with producers had to do with production and the growing of two blades of grass where one grew before has brought about a demand that the extension man, and through him other workers in the agricultural field, do more than show how to produce more. Hence the demand has grown that extension work should specifically attack the problem of how to help farmers make more money, and I would give two aims of extension work, first, to make farming more profitable and, second, to improve living conditions on the farm. Any extension work that does not further one or both of these aims is not worthy of being called extension work and is not wanted by producers. These two aims are closely connected because better living conditions are only possible to a very great extent as farm incomes are increased. It might be stated though that it is often the urge of obtaining a new car, a better house, or up-to-date clothes that results in producers working harder in order to obtain these evidences of improved living conditions. This paper will have to do with the question of economic information looking to increased income, while the matter of improved living conditions will not be further elaborated.

It might be stated that the speaker went into the economic field as a result of his extension activities in the Red River Valley. As a county agent in that district of the Mid-West the farmers wanted to know what to produce, how to produce it, how to sell it. What for? In order that the producers might increase their incomes. Thus it was that when I came to take graduate work, it was in economics, because I believe that in extension work it is this field which has been neglected and it is in this field that the greatest possibilities are awaiting us in furthering our work amongst producers. The division which I am making is not necessarily in sequence but rather it is an attempt to classify economic activities in extension work.

Types of Farming

This is placed first because after all the type of farming to be followed in any district or on any farm is of first importance. Often proper selection of type of farming in any district may call for a detailed survey, but an extension man cannot delay action until such a survey is made; he has

[1]Paper read at the annual meeting of the Canadian Society of Agricultural Economics at Guelph, Ontario, June 23-24, 1931.

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to make use of available data and act accordingly. Although Canada is a young country, we already have sections where farms have been abandoned; we have had people moved from districts that were not adapted to farming; other districts should be abandoned because farming cannot be made profitable in such districts. Still, in very recent years we have placed people in districts not adapted to farming and men on farms that cannot be operated profitably. The extension man cannot afford to be a partner to such practices. Then there is the furthering of types of farming not adapted to a district. Take the instance of agricultural men seeking to promote dairying and purebred stock raising in a district where the average farm could only carry two or three cows per farm; or hogs in a district scarcely capable of producing roughage for two or three cows per farm let alone grain for the hogs. These districts did not need, as a primary consideration, purebred dairy cows or brood sows; rather they required poultry, truck crops, small fruits and proper soil and cultural treatment. I happen to know of a county agent who sponsored a certain variety of potatoes in his district only to have his successor institute a campaign to replace this variety by an earlier variety, one which was better adapted to the territory. Results from type of farming campaigns may well be illustrated by three adjoining counties in a small grain area. One county agent sought to develop a second cash crop by recommending potatoes for areas in his county adapted to their growth. During a period of ten years the acreage of potatoes in this county was increased from one-half acre to seven acres per farm while the acreage in the other two counties, equally well adapted to potatoes, but where no like campaigns had been conducted, had increased from one-half acre per farm to only three and one-half acres per farm. Part of this increase could be attributed to the proximity of these two counties to the other county.

Thus the first essential in extension work is the proper analysis of the agriculture in the county, district or province and the furthering of types of farming adapted to conditions. This implies a knowledge not only of the people, their ability and knowledge of farming, but also of soil, topography, markets, size of farms, climate and other factors which enter into the growth of crops or the raising of live stock.

Rural community organizations as farmers clubs can well appoint committees to discuss with the economic specialist or extension worker types of farming best adapted to the community. Thus a community programme of work can be outlined and this programme promoted through the organizations.

Agricultural Outlook

Farmers are interested in trends in production, the market outlook, and probable prices. The short time viewpoint is too often taken by producers, and as a result acreage of any crop tends to be correlated with price the preceeding year. Potato yields tend to be lower following years of low prices due no doubt to the poorer care given. Even with no difference in acreage in apples a very definite relationship between price one year and production the following year has been shown to exist in the Annapolis Valley. The effect of price is also reflected in acreage and in yield per acre through care for more than one year. With prices of dairy

cows falling and already down very decidedly in most parts of the country, dairy farmers in Nova Scotia this year are keeping more than the usual number of heifer calves. Why? Certainly not because of any market that exists for dairy stock or will exist in the near future, but rather because of the high prices of the past few years. A certain area in the Mid-West has been purchasing sheep, a district that had few sheep until during the recent period of high prices. This was brought about through a sheep campaign which was furthered by definite organized work, and breeding ewes were placed at high prices. Already, with reduced prices, newly acquired flocks are in a few instances being sold at the stock yards and more are bound to follow.

Instances could be multiplied to show the lack of economic information on the part of producers respecting trends in the production of agricultural commodities, and, sad to relate, such lack of information is not confined to producers but is also shared by many of those who would instruct the farmers in what and how to produce. There is the instance of the spring of 1921 when wheat prices were down and potato prices were high; then bankers were willing and anxious to finance producers in the production of greatly increased acreages of potatoes, acreages that in many instances both in parts of Canada and the United States were never dug. Men of our own group have not been free from criticism for recommendations given along such lines, recommendations which were not in line with facts because of the short time viewpoint taken.

There are those who claim that such information will not be accepted by producers. We cannot expect producers to accept such information promptly; rather it is a question of education. Considering the reliability of information which has been given in the past, it is not to be wondered at that producers often hesitate. The results obtained by the United States Department of Agriculture through the Agricultural Outlook Conference, and the gradual adaptation of the type of information obtained to state and local conditions, and the increased use of such material in farmers meetings are the best evidences of the interest and need for data of this nature. Agricultural Outlook material can also be placed before producers through the press and through pamphlets. More and more in the outlook work in the states to the South this material is being used at meetings held during the winter and attended by the specialist. Direct contact, where local application of this information can be made is very desirable.

Do not take from this that such information is infallible. It is not, due in part to our lack of proper data either of past or present production or of production over a wide enough area. The "intention to plant" data now being collected by the United States Bureau of Agricultural Economics is a further extension of this idea and an attempt to forestall poorly adjusted production.

There is a place and a very large one for agricultural outlook material in Canada. It is to be hoped that ways and means will be found for the Agricultural Economics Branch in the Dominion Department of Agriculture to undertake work of this type. True, its proper functioning will take time but a start must be made and the earlier the better. Extension

work cannot ignore this type of information, and must have the proper data on which to base the work if it is to meet the needs of producers.

Farm Records

Extension work may carry to the farmer the results of the work done at experiment stations but it should also seek to find the outstanding successful farmers in any county or district, learn the methods which they employ, and thus provide the means of extending these methods in the county or district.

It is here that farm records are needed, for through the keeping of farm records successful farmers are found and proper material is made available from these farms. By the keeping of records, the individual farmer can study, with the assistance of those connected with extension work, the problems of farm management on a specific farm and make needed corrections in management that will aid in furthering profitable farming.

The keeping of farm records has probably been carried further in Illinois than in any other State or Province. There are approximately 2500 farmers who co-operate with the extension service in that State by sending their accounts to the University for analysis. There is also the Farm Bureau Farm Management Service through which 840 farmers pay from $15 to $35 a year in order to secure farm management assistance. Under this plan a farm management specialist has a certain group of farmers with whom he works and whose accounts he analyses; he then seeks to make such changes in the management of these farms as the records show desirable.

This is a type of work which is producing big returns in many parts of the United States. It is a type of work in which the best class of business farmers is interested. It is, however, a service that requires trained men to supervise. Thus far such work has barely been touched in Canada. While we have farm account books and farmers keeping records both on their own initiative and with the co-operation of extension workers, the work is not organized on a scale even approaching that found in many states to the south.

Farm Organization

This might well be grouped with farm records because the two are closely connected. Proper farm records point the way to improved organization of the farm unit for production purposes. The distribution of labour, its proper use, the quantities of live stock to be maintained, the proper distribution of the cropped acreage, the use of fertilizers, insecticides and fungicides, the type and extent of the use of machinery and power all enter in under farm organization. Often the lack of profits on a specific farm is not due to want of proper soil, or proper adaptation of type of farming to soil conditions or to region, or even to lack of hard work on the part of the operator, but is rather due to lack of proper organization of the work.

Industry has studied how to increase the efficiency of labour employed. This has only been done as industrialists have been forced to do it by mounting wage schedules and the absolute necessity of better organiza-

tion in order to make profits in the business. The efficiency expert has come to be a recognized necessity in the factory and office. If farmers are to compete with industry for labour, if they are to maintain their standard of living, if they are to make conditions on the farms such that the young people will stay there, like measures must be taken. Ordinary farm practices whether plowing, cultivating, picking of apples, husking of corn or like operations must be studied and steps taken to reduce the labour required and reduce costs. The very fact that in the same community, under similar conditions, records show that certain men have built up profitable farm businesses while others are heavily in debt is the best evidence of the need of better farm organization and of increased attention to the proper use of land, labour, capital and management in production.

Budgeting

Department men as well as many commercial men have heard much of budgets and budgeting but this term as applied to farms is of comparatively recent application. It is applied to the probable production, receipts, expenses and net income on farms. It is an attempt to make use of available data on any specific farm in the planning of the work for the year. In itself it is nothing new as farmers have always tended to plan their work in advance in so far as crops grown, stock kept, machinery used and methods followed are concerned. Budgeting as now practised is an endeavour to place such planning on a better basis and to seek to make use of records available, production trends and other data.

The increased competition in the production of farm products, the ever increasing specialization in agriculture, the competition of organized industry for the factors of production all tend to stress the need of greater attention being given by farmers to the study of their problems and the planning of their farm operations in advance. Economic changes in the world today are much more rapid and more complex than ever before in the history of the world. Changes are constantly occuring in the demand for products, and other countries continue to enter in as important factors in world production. All these factors must be reflected back on the farm and must be considered in the planning of operations.

Marketing

Extension work is education, and as such, information as to marketing functions, market organizations and markets comes within the extension field. This has been sadly neglected in much of our extension work, and it is this neglect which is often a fundamental cause in the failure of co-operative organizations to function properly. Too often marketing has been attacked separately from what is more often termed as production. The two should go forward together and any programme seeking to further production should include both. Quality production is only furthered through definitely organized objectives and through organizations that will carry back to the producer a premium for quality. Canadian wool was of a very mediocre quality until a co-operative organization was formed which in place of paying for wool on a flat basis, collected it, graded it, sold it on the graded basis and returned the proceeds to the growers, paying on a quality basis. Prince Edward Island potatoes com-

mand a premium on the Boston market because of the quality product which is being forwarded to that market through the medium of a co-operative organization. I am not holding here that a co-operative organization is essential, but I am holding that price returns must be commensurate with quality delivered by the producers and that it is only where proper methods are employed in carrying this through that quality production is possible.

Information on marketing organizations, and on markets and prices of the respective commodities produced in any community is essential for use in extension work, and this information must be passed on to the producer. In the past many a co-operative has been organized which has attempted to function on a price basis and a price basis only. Such a co-operative fails to realize its greatest possibilities and is bound to fail. Relation to supply and demand and how markets function are sometimes not even understood by would-be leaders, let alone by the members. Information on these lines must be made available in extension work and must be carried to producers. Only as we train an intelligent group of producers informed as to these matters can we hope to lay the proper foundation for the functioning of co-operative organizations.

Boys' and Girls' Club Work

While club work is not usually considered as a means of furthering economic information in extension work, still, several forms of economic information are being furthered by this means. Community breeding is being so developed, thus aiding in bringing about co-operation in production. New crops, improved seed, better methods are often aided by this means. Co-operation in any community may be advanced by training the young people in working together. Records form a part of club work and aid in training our young people in the proper keeping of records. In years to come these will aid in spreading the use of farm records, and in a better understanding of farm organization. Farm management projects are feasible with older club members and are one means of aiding in the studying of management problems. As club work grows, economic information can be spread more and more through these means. Members now being trained in project recording and in the studying of crop and live stock problems will, in a few years time, be our best material for the keeping of farm records for the studying of farm management problems and for the development of organized activities.

Methods of Approach

The wide variation in the type of economic material calls for different methods of placing such information before the producers. Information on types of farming and on the Agricultural Outlook can well be used at general meetings. The former subject, however, is one which should be discussed by committees in each community. That is, action as to type of farming must be taken by the individual and by the community. Farmers' organizations such as farmers clubs should have committees which will first take up and discuss a community programme in which types of farming to be followed can be made a part.

Most farm management material is much better spread through small groups of farmers than at general meetings. Thus the reports of an economic farm survey should be carried back to meetings of the farmers interested, where the results can be discussed by the economic specialist with small groups. The keeping of farm records must be stimulated through individual work but can also be discussed at group meetings. Much better progress will be made where small groups meet with the economic specialist or the extension worker to discuss the records. The results of the records should also be discussed with the individual farmer on his farm. It is because of the work involved that Illinois has placed this work in many districts on a basis where the farmer pays for the service.

Information relative to marketing can be placed before producers at general meetings, also through the co-operative marketing organizations. The units of such organizations offer an excellent field for this type of work.

Summary

The urge on the part of producers today that extension work must meet their needs must be met if extension work is to survive. A challenge is being issued to us today which we cannot ignore due to present world-wide business conditions. It can only be met by the use of economic information in extension work and the proper tie-up in farm organization, and by furthering not only the actual production of commodities but their marketing as well. The question of dollars to the producer, of a profitable agriculture, must be constantly kept to the fore. If extension work fails to show the individual farmer how he can increase his income then it must go into the discard. The urge for the use of such information implies that economists must make available the necessary data for the development of these lines of work. This is not a short time programme; rather it is a long time programme, and we must be prepared to meet the need and further the obtaining of the necessary data. Already surveys have been made in many agricultural districts in Canada and more are under way. This work needs to be extended and other activities added. Once obtained, such economic material must be made available to the producers in a manner that can be understood.

SOME FACTORS AFFECTING THE WEIGHT OF EGG IN DOMESTIC FOWL

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The importance of any factors which may affect the weight of eggs laid by the domestic fowl is becoming increasingly great.

The economic significance of the production of large eggs has led to many studies of the physical factors which might affect the weight of eggs laid by the common breeds of fowl. Atwood (*2*), Hall (*11*), Lehman (*15*), Atwood and Clark (*4*), and Marble (*16*), have reported significant relationships between the mean or the maximum body weight of White Leghorn females and the weight of their eggs. While the results of Hadley and Caldwell (*10*), and Jull (*14*), working with Plymouth Rocks, do not tend to confirm these findings, Robertson (*23*) has shown that an extremely close association existed between body and egg weights of the various breeds of fowl entered in the Canadian Egg Laying Contests. Age at maturity does not appear to affect, significantly, the mean annual egg size according to the work of Atwood (*2*), and Marble (*16*). Annual production and mean annual egg weight have been found to vary independently in studies by Hadley and Caldwell (*10*), Parkhurst (*20*), Atwood and Clark (*4*), and Marble (*16*).

Reports on the association between the mean egg weight of daughter with that of dam or sire's dam are not numerous. Benjamin (*7*) has shown correlation of $0.22\pm.05$ between the egg weight of the dam and daughter: $0.36\pm.04$ between that of the sire's dam and daughter, and $0.42\pm.04$ between the mean egg weight of the daughter and the mean of the egg weights of the dam and the sire's dam. Marble (*16*) reports correlations closely approximating those of Benjamin.

Marble (*16*), whose study includes data gathered from over fourteen hundred White Leghorn females, subjected most of the physical and genetic factors supposed to have relationship with egg size to partial correlation methods for analysis. The results of this study could account for only forty-two per cent of the sum total of the factors influencing egg weight. The correlation between body and egg weight was shown to be the most important relationship so far discovered.

Atwood (*1, 2, 3*) found that the weight of eggs laid by domestic fowl may be affected by feeding a scanty or poorly balanced diet. Various monotonous diets, each containing a purified protein of different origin as the variable, have been shown to affect the egg size of pigeons in the experiments of Gerber and Carr (*9*). While Newman (*18*) found that the mean egg weight was lowered with earthnut meal only when fed in comparison with meat scraps, milk powder and fish meal, Parkhurst (*20, 21, 22*) has presented data which tend to show that the protein concentrate fed in balanced diets may be a factor in the determination

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of egg weight. Orr (*19*) and co-workers have reported that the mineral content of the diets of laying birds may affect the size of eggs.

The study here reported is made on the data collected from the records of the British Empire Marketing Board—Ontario Government experiment, planned to study the factors affecting hatchability. This work is being carried on at the Poultry Department of the Ontario Agricultural College.

Plan of Experiment

The general plan of the experiment was to study the influence of such animal proteins as milk, fish scrap, beef scrap, and tankage, as they might affect hatchability and egg production. These materials were used as the source of protein concentrate in the ration and, in addition, were fed in combination with milk, with or without cod liver oil. The pullets used in the experimental trial are all of known ancestors and come from the general pedigree pens of the Department. Their ancestors are known for ten or more years, together with their record of performance. This information may help materially in the final study of the problem. The incubator used was a six thousand egg 'Petersime' machine, which makes it possible to set all eggs daily for the entire period. This insures that all eggs are set the day they are laid and that every egg is under the same external conditions during incubation. The birds were weighed individually once each month to the nearest ounce. Each egg and chick weight was recorded to the nearest gram.

Twenty Barred Rock pullets and one male, as nearly similar in age and breeding as possible, are used in each pen. In case of the death of a bird, it is immediately replaced by a bird of similar breeding, so that the pens are constantly kept up to strength.

It is planned to conduct the trial for five years, which would give data on one hundred females on each ration being studied.

The individual pens are twelve feet wide and fourteen feet deep. There are two glass windows, three feet by three feet six inches, in each pen, as well as two movable screens which may be opened on days when the weather permits. The screens are twenty inches square. One is covered with cheese-cloth and the other is covered with cel-o-glass. The trap-nests, drinking fountains, pans, and feed hoppers are the same size in each pen. There should be little or no difference between the pens.

The Method of Feeding and Management

In view of the many factors that may affect production, and also hatchability, a system of feeding and management has been developed to control as many of these as possible, on a measurable basis. With this in mind the following feed schedule was carried out:

A.M.: A light feed of grain scattered in the litter;
Noon: Moist mash in troughs;
P.M.: A heavy feed of grain was fed in troughs.

No artificial lights were used.

Rations for Experimental Pens

Basal Mash to All Pens

700 lbs. corn chop
500 " wheat shorts
300 " oat chop
10% alfalfa meal
2½% bone meal
½% salt

Whole Grain Mixture

50 lbs. yellow Argentine flint corn
50 lbs. wheat

Daily amount to each pen:
A.M. ½ lb. in litter.
P.M. 2 lbs. in hopper.

To the dry mash, kept in front of the birds all the time, was added the following:

Pen	*Amount and Kind of Protein*	*Other Additions*
2	10% B.M.P. (Buttermilk Powder)	U.V.L. (Irradiation) *
4	10% B.M.P.	C.L.O. (Cod Liver Oil) †
6	5% B.M.P. + 7½% F.S. (Fish Scrap)	
8	5% B.M.P. + 7½% F.S	C.L.O.
10	5% B.M.P. +10 % B.S. (Beef Scrap)	C.L.O.
12	5% B.M.P. +10 % Tankage	C.L.O.
18	20% B.S.	C.L.O.
20	10% B.M.P.	
22	20% B.S.	
24	20% Tankage	
26	15% F.S.	
28	15% F.S.	C.L.O.
30	20% Tankage	C.L.O.

* U.V.L. (Ultra Violet Light) half hour irradiation daily, except Sundays;
† C.L.O. (Cod Liver Oil) 20 c.c. daily to each pen in moist mash.

In addition to the dry mash, the birds have free access to oyster shell, grit, and water at all times. The weighed quantity of grain (2½ lbs. per pen per day) was fed in an assumed ratio of 50-50 mash to grain consumption. By this method any variation in food consumption was measured by the amount of dry mash and oyster shell eaten.

The protein supplements were added on an equivalent basis to the basal mash, with the exception of milk. Small quantities of the basal mash were weighed out in separate containers weekly and the animal proteins were added to the various groups.

A chemical analysis of each individual source of protein was determined. An equivalent quantity of fish scrap, beef scrap, and tankage was fed on the basis of their chemical analysis, as stated previously, with the exception of milk, of which one-half of the quantity by weight was used.

This source of data affords an excellent opportunity to study the relationships between the body, egg, and chick weights in domestic fowl. Work of this nature, especially when larger numbers have been incorporated in the data, has been based on studies of breeds other than Barred Plymouth Rocks. The Barred Plymouth Rock is the most popular breed of farm fowl in Ontario. It is, therefore, of value to know if the relationships between body, egg, and chick weights in this breed are similar to those found for other breeds.

The plan of the experiment is such that there are available the records of pullets fed on diets containing the various commonly used protein supplements fed with and without the addition of cod liver oil. The results from the feeding of these diets are strictly comparable, as the birds were kept under the conditions of a well performed nutrition experiment. These data, therefore, should show with some degree of reliability any relationships which might exist between the feeding of different protein concentrates properly balanced in the diets and the weight of egg produced.

In analyzing the data the machine methods of Wallace and Snedicor (*24*) were used, unless otherwise stated in the text. The maximum weight obtained by each bird between the months of February to July, inclusive, has been taken for the weight of bird (X). The weight of egg (Y) and the weight of chick (Z) are represented as the mean weight of the total production of each individual.

In the sections of this paper which deal with the effects of cod liver oil in the diets of laying birds it must be remembered that the data have been gathered under Ontario climatic conditions. This means that the birds are subject to less than two hundred hours of sunlight for each of the months of February, March and April, and that the temperature of the pens is relatively low until the middle of March. The conclusions drawn, therefore, may not be valid for different conditions of light and climate.

Results

The results may be grouped into two classes:

1. The relationships of physical factors;
2. The relationships of nutritional factors.

1. THE RELATIONSHIPS OF PHYSICAL FACTORS.

A. *The Relationship between Body Weight and Egg Weight.*

(a) The relationship between *maximum* body weight and mean egg weight for the entire period studied is shown in table 1. The data gathered

TABLE 1.—*Showing the coefficient of correlation (r.) between mean egg weight and maximum body weight from all data.*

$\Sigma X = 5{,}511.27$	$\Sigma Y = 48{,}702.1$	$N = 913$
$MX = 6.04$ pounds	$MY = 53.3$ grams	$\Sigma XY = 295{,}675.2$
$\Sigma X^2 = 33{,}984.46$	$\Sigma Y^2 = 2{,}615{,}147.3$	$\Sigma Y(MX) = 294{,}160.7$
$\Sigma X(MX) = 33{,}289.28$	$\Sigma Y(MY) = 2{,}595{,}821.9$	$\Sigma XY - \Sigma Y(MX) = 1{,}514.5$
$\Sigma X^2 - \Sigma X(MX) = 695.18$	$\Sigma Y^2 - \Sigma Y(MY) = 19{,}325.4$	
$\sqrt{\Sigma X^2 - \Sigma X(MX)} = 26.4$	$\sqrt{\Sigma Y^2 - \Sigma Y(MY)} = 139.0$	

$$r. = \frac{\Sigma XY - \Sigma Y(MX)}{\sqrt{\Sigma X^2 - \Sigma X(MX)} \quad \sqrt{\Sigma Y^2 - \Sigma Y(MY)}} = 0.4127$$

$$P.E. = \pm .6745 \frac{1 - r}{\sqrt{N}} = \pm 0.0185$$

from 913 Barred Plymouth Rock Pullets, during the six months' period February to July inclusive, 1928, 1929, 1930, show a positive and significant correlation of 0.412 ± .018 between the maximum body weight and the mean weight of egg. The biometric treatment is shown in table 1. This expression of correlation is in close approximation to the results cited above and quite confirmatory in nature to the majority of findings.

(b) Comparison of data from the separate years.

Table 2 shows the number of birds included in these data for the three years, together with the mean egg weight and the average of the maximum weight attained by each bird. Under the symbol r. is represented the coefficients of correlation between maximum body weight and mean egg weight for each period.

TABLE 2.—*Showing the number of birds, mean maximum body weight, mean egg weight, and coefficient of correlation between egg and body weight for the years of experiment.*

Year	N No. of Birds	MX Maximum Body Weight: Pounds	MY Mean Egg Weight Grams	r Coefficient of Correlation
1928	261	6.19	52.4	0.608 ± .026
1929	342	6.11	54.1	0.534 ± .026
1930	310	5.82	53.3	0.453 ± .030
1928-'29-'30	913	6.04	53.3	0.412 ± .018

It is interesting to note that the value of r., representing the coefficient of correlation between egg and body weight for each of the individual years, is greater than when these data are calculated in combination. The value for the coefficient of correlation (r.) is also seen to change considerably from year to year. Fluctuations in the value of this coefficient have often been attributed simply to differences in "strain" from which the data were gathered. The data here presented represnts birds of the same breeding. It would, therefore, seem that tendencies toward fluctuations in the value of r., representing the coefficient of correlation between body and egg weight are at least in part dependent on factors other than the "strain" of breeding.

(c) Comparison of the data of 1929 by Months.

Table 21 shows the scatter diagram of the egg and body weights for the year 1929. These data differ in their presentation to the 1929 data shown above, in that each monthly weight of pullet and the respective mean monthly weight of egg is considered as a separate individual. A bird laying in all six months during which records were taken will, therefore, be shown six times on this diagram instead of once as before.

When monthly weights are taken individually the value of r., representing the coefficient of correlation between body weight recorded at the first of the month and the mean egg weight for the month, is 0.317 ± .031.

Contrasting this figure of 0.317 for the monthly coefficient with 0.534 ± 026, the coefficient for the six months' period, a difference of some considerable size is found. This difference is found in analysis of the same records.

TABLE 3.—*Showing the coefficient of correlation between egg weight and chick weight when hatched from the same eggs.*

$\Sigma Y = 14{,}583.5$	$\Sigma Z = 9{,}028.2$	$N = 270$
$MY = 54.0$ grams.	$MZ = 33.4$ grams.	$\Sigma YZ = 490{,}170.9$
$\Sigma Y^2 = 791{,}930.0$	$\Sigma Z^2 = 303{,}908.7$	$\Sigma Y(MZ) = 487{,}089.9$
$\Sigma Y(MY) = 787{,}509.0$	$\Sigma Z(MZ) = 301{,}541.8$	$\Sigma YZ - \Sigma Y(MZ) = 2{,}366.9$
$\Sigma Y^2 - \Sigma Y(MY) = 4{,}421.6$	$\Sigma Z^2 - \Sigma Z(MZ) = 2{,}366.9$	
$\sqrt{\Sigma Y^2 - \Sigma Y(MY)} = 66.5$	$\sqrt{\Sigma Z^2 - \Sigma Z(MZ)} = 48.7$	

$$r. = \frac{\Sigma YZ - \Sigma Y(MZ)}{\sqrt{\Sigma Y^2 - \Sigma Y(MY)}\ \sqrt{\Sigma Z^2 - \Sigma Z(MZ)}} = 0.9516$$

$$P.E. = \pm .6745\ \frac{1-r}{\sqrt{N}} = 0.0039$$

The following graphs, numbers 1 and 2, represent the trend of changes in egg and body weight of the birds included in the 1929 data. The egg and body weights follow the same general trend. It may be seen, however, that a fall in body weight is preceded by a fall in egg weight and that these trends are not concurrent.

It has been shown above that the relationship existing between the mean maximum body weight of bird and the mean weight of egg laid is closer for a period of six months' duration than when the data are calculated on a monthly basis. The fact that the graphs of the egg and body weight trends are not concurrent substantiates evidence to show that in these data the weight of bird taken for any one month is a less reliable index of her egg weight than is the maximum weight taken between February and July inclusive.

B. The Relationship between Weight of Egg and Weight of Chick.

Table 3 shows the coefficient of correlation between the weight of egg set and the weight of chick hatched from the same egg to be 0.951 ± .003.

When the criterion for egg weight is simply the mean for eggs set, regardless of whether they hatch or not, the coefficient of correlation is shown to fall to 0.461 ± .032. In table 4 a comparison of the mean egg weight values shows that this is not due to a significant decrease in egg size. This fact would suggest that there is little indication in these data that the size of egg, within normal bounds, has an appreciable affect on its hatching power.

The association between egg size and chick size is so close that it may be concluded that the weight of egg set practically determines the weight of chick which will be hatched.

2. NUTRITIONAL FACTORS AFFECTING THE WEIGHT OF EGG.

Major differences in modern poultry diets are often found in variations in the protein supplements. It is, therefore, of importance to know if these variations affect the weight of eggs laid by birds fed on diets so supplemented.

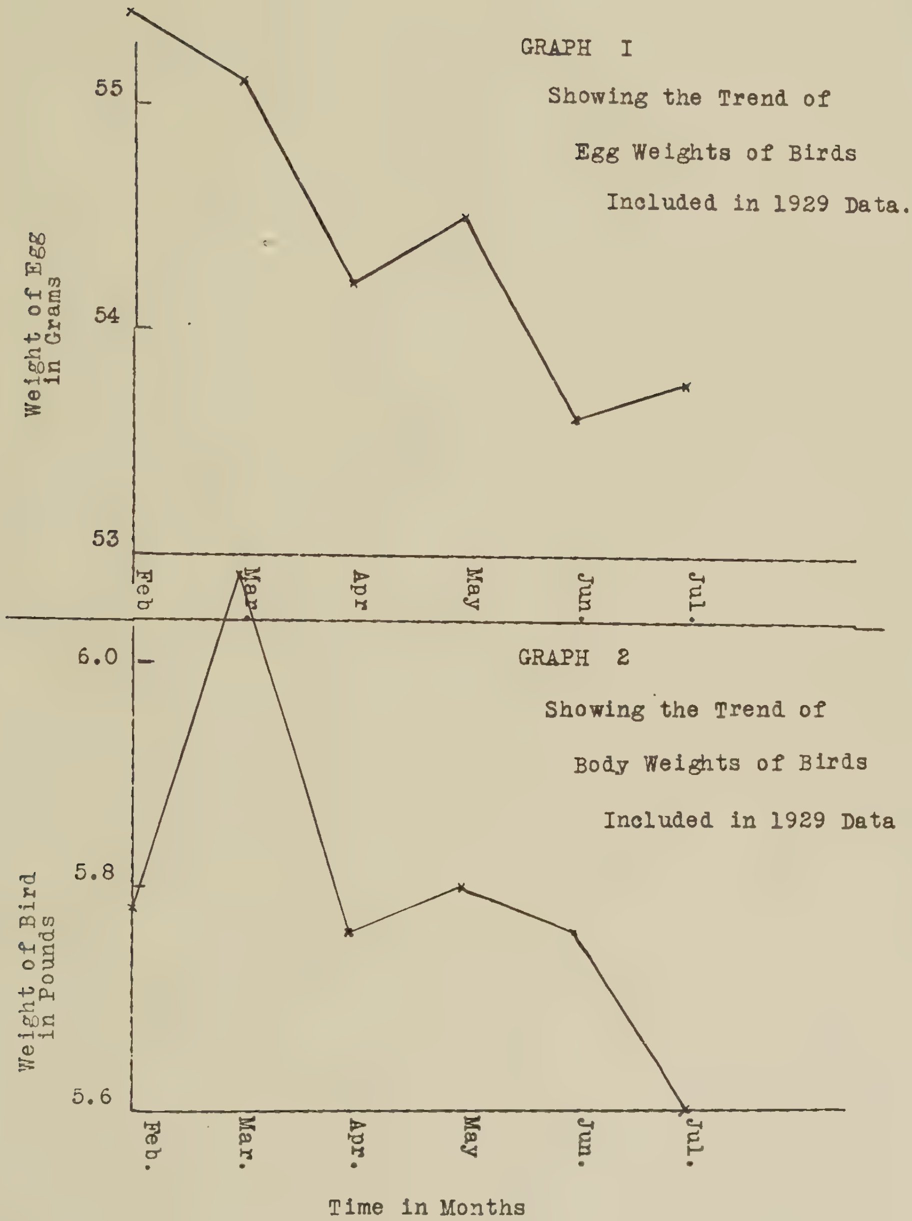
GRAPH I
Showing the Trend of
Egg Weights of Birds
Included in 1929 Data.
Weight of Egg in Grams
55
54
53
Feb
Mar
Apr
May
Jun.
Jul.
GRAPH 2
Showing the Trend of
Body Weights of Birds
Included in 1929 Data
Weight of Bird in Pounds
6.0
5.8
5.6
Feb.
Mar.
Apr.
May
Jun.
Jul.
Time in Months

TABLE 4.—*Showing the coefficient of correlation between mean egg weight and mean chick weight when all eggs set are considered as in mean weight calculations.*

$\Sigma Y = 14{,}642.6$	$\Sigma Z = 9{,}028.2$	$N = 270$
$MY = 54.2$	$MZ = 33.4$	$\Sigma YZ = 490{,}170.9$
$\Sigma Y^2 = 796{,}064.3$	$\Sigma Z^2 = 303{,}908.7$	$\Sigma Y(MZ) = 489{,}062.8$
$\Sigma(MY) = 793{,}628.9$	$\Sigma Z(MZ) = 301{,}541.8$	$\Sigma YZ - \Sigma Y(MZ) = 1{,}108.1$
$\Sigma Y^2 - \Sigma Y(MY) = 2{,}435.4$	$\Sigma Z^2 - \Sigma Z(MZ) = 2{,}366.9$	
$\sqrt{\Sigma Y^2 - \Sigma Y(MY)} = 49.3$	$\sqrt{\Sigma Z^2 - \Sigma Z(MZ)} = 48.7$	

$$r. = \frac{\Sigma YZ - \Sigma Y(MZ)}{\sqrt{\Sigma Y^2 - \Sigma Y(MY)}\ \sqrt{\Sigma Z^2 - \Sigma Z(MZ)}} = 0.4615$$

$$P.E. = \pm .6745 \frac{1 - r}{\sqrt{N}} = \pm 0.0323$$

Relationships between diet and various factors under consideration in this paper are shown in table 5.

TABLE 5.—*Showing the condensed data from the individual diets.*

Pen No.	N Number of Birds	MX Mean of maximum body weight (pounds)	MY Mean Weight of Eggs laid (grams)	r. Coefficient of correlation X to Y
2	65	5.84 ± .084	53.7 ± .657	0.732 ± .038
4	63	5.89 ± .059	53.7 ± .339	0.262 ± .079
6	54	6.04 ± .118	52.3 ± .321	0.945 ± .009
8	58	6.11 ± .078	53.9 ± .327	0.290 ± .081
10	59	6.11 ± .069	53.5 ± .359	0.325 ± .078
12	56	6.02 ± .070	53.3 ± .358	0.566 ± .061
18	55	6.12 ± .087	53.0 ±1.075	0.008 ± .091
20	52	6.14 ± .073	52.9 ± .336	0.465 ± .073
22	55	6.11 ± .080	53.2 ± .381	0.600 ± .058
24	58	6.06 ± .069	52.8 ± .336	0.478 ± .068
26	58	6.18 ± .061	53.4 ± .282	0.151 ± .086
28	57	6.03 ± .079	53.7 ± .320	0.372 ± .077
30	52	5.83 ± .065	54.4 ± .420	0.470 ± .072

In this table large differences in the values of the different coefficients of correlation between body and egg weight, as determined, are apparent. The mean maximum body weights and the mean egg weight values are strikingly similar.

A. The Effect of Feeding Different Protein Concentrates on the Weight of Eggs.

Three years' data, gathered from pens on the four protein supplements when fed singly in the experiment, are shown in table 6. Approximately half of the birds represented in this table were fed a diet of basal ration, plus protein concentrate, plus cod liver oil. The other half received a diet of basal, plus protein concentrate, without the addition of cod liver oil.

TABLE 6.—*Showing condensed data from pens receiving the different protein concentrates.*

Protein Concentrate	N	MX Maximum weight of bird (lbs.)	MY Mean weight of eggs (gm.)	r. Coefficient of Correlation Egg wgt. Body wgt.
Buttermilk Powder	180	5.94 ± .130	53.5 ± .275	0.206 ± .048
Meat Meal	110	6.11 ± .044	53.1 ± .202	0.385 ± .043
Tankage	110	5.95 ± .039	53.6 ± .200	0.473 ± .039
Fish Meal	115	6.10 ± .042	53.7 ± .199	0.338 ± .044

Statistically the difference in mean egg weight and mean maximum body weight, shown in table 6, are not significant. This indicates that the affect of varying the nature of the protein concentrates in the ration has no influence on the weight of egg produced.

TABLE 7.—*Showing the condensed data from pens in which different protein concentrates were fed with the addition of cod liver oil.*

Protein concentrate	Pen No.	N	MX Mean maximum body weight (pounds)	MY Mean weight of eggs laid (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Buttermilk Powder	4	63	5.89 ± .059	53.7 ± .339	0.262 ± 0.079
Meat Meal	18	55	6.12 ± .087	53.0 ±1.075	0.008 ± 0.071
Tankage	30	52	5.83 ± .065	54.4 ± .420	0.470 ± 0.072
Fish Meal	28	57	6.03 ± .079	53.7 ± .320	0.372 ± 0.077

TABLE 8.—*Showing the condensed data from pens in which different protein concentrates were fed without the addition of cod liver oil.*

Protein concentrate	Pen No.	N	MX Mean maximum body weight (pounds)	MY Mean weight of eggs laid (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Buttermilk Powder	20	52	6.14 ± .073	52.9 ± .336	0.465 ± .073
Meat Meal	22	55	6.11 ± .080	53.2 ± .381	0.600 ± .058
Tankage	24	58	6.06 ± .069	52.8 ± .336	0.478 ± .068
Fish Meal	26	58	6.18 ± .061	53.4 ± .282	0.151 ± .086

Tables 7 and 8 have been made directly from table 5. Table 7 presents the data from diets in which single protein concentrates added to the basal ration are supplemented with two per cent of cod liver oil. Table 8 represents the data from similar diets unsupplemented by cod liver oil.

If any relation exists between the protein concentrate in the diet and the weight of egg, significant differences should appear in the mean body weight or the mean egg weight columns of table 8. The individual components of these columns, however, show remarkable similarity. The small differences that do occur are entirely without statistical significance. This provides additional evidence that the protein concentrates fed do not have a marked influence on the weight of egg.

An examination of table 7 shows larger fluctuations in the individual values found in the mean body and mean egg weight columns than those found in table 8. The birds represented in this table were kept as nearly as possible under the same conditions as those represented in table 8. The data brought forward in both tables represent a random sample from nine hundred birds of similar breeding. Aside from the addition of two per cent of cod liver oil to those rations represented in table 7, the diets are strictly comparable. Therefore, in table 7 any significant changes in the values of the mean body or egg weights from those of the respective rations represented in table 8 might well be attributed to the addition of two per cent of cod liver oil to the diet.

TABLE 9.—*Showing the condensed data from pens where combinations of two protein concentrates were fed together with cod liver oil.*

Protein concentrate	Pen No.	N	MX Mean maximum body weight (pounds)	MY Mean weight of eggs laid (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Buttermilk Powder Fish Meal	8	58	6.11 ± .078	53.9 ± .327	0.290 ± 0.081
Buttermilk Powder Meat Meal	10	59	6.11 ± .069	53.5 ± .359	0.325 ± 0.078
Buttermilk Powder Tankage	12	56	6.02 ± .070	53.3 ± .368	0.566 ± 0.061

TABLE 10.—*Showing the condensed data from pen 6 to which no Cod Liver Oil is fed.*

Protein concentrate	Pen No.	N	MX Mean maximum body weight (pounds)	MY Mean weight of eggs laid (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Milk and Fish Meal	6	54	6.04 ± .118	52.3 ± .325	0.946 ± .009

Tables 9 and 10 show the values for mean egg weight, mean body weight and the coefficient of correlation between body and egg weight when the protein concentrate milk is fed in combination with the other concentrates as shown in the basal mixture.

Tables 9 and 10 are comparable with tables 7 and 8, as with the rations represented in tables 7 and 8 no significant differences in the mean egg or body weight columns can be shown to be the effect of the different protein concentrates.

Table 11 is presented to show the annual changes in the values for mean maximum body weight and mean egg weight during the period covered by this study.

The results of feeding the diet basal, plus milk, plus fish (Pen 6), are of interest in that the mean egg weight values are somewhat lower than those from the different rations with which it has been compared. While in these data this difference is statistically insignificant, it is possible that with an increase in numbers under investigation significance of this figure might be shown.

TABLE 11.—*Showing the mean maximum body weight and mean egg weight for each pen for each of the three years.*

Protein Concentrate fed	Pen No.	C.L.O. NO C.L.O	MX Mean maximum body weight (pounds)			MY Mean individual weight of egg (grams)		
			MX 1928	MX 1929	MX 1930	MY 1928	MY 1929	MY 1930
Buttermilk Powder	2	U.V.L.	6.48	5.54	5.88	53.8	53.5	53.9
Buttermilk Powder	4	+	6.14	5.98	5.50	51.9	54.8	53.5
Buttermilk Powder and Fish Meal	6	—	6.28	6.23	5.76	53.2	52.8	51.0
Buttermilk Powder and Fish Meal	8	+	6.34	6.18	5.78	53.2	54.7	53.4
Buttermilk Powder and Meat Meal	10	+	6.56	5.95	5.88	53.6	53.7	53.1
Buttermilk Powder and Tankage	12	+	6.01	6.25	5.79	52.3	53.3	54.0
Meat Meal	18	+	6.15	6.58	5.66	52.3	53.5	53.1
Buttermilk Powder	20	—	6.49	6.37	5.69	53.2	53.2	52.3
Meat Meal	22	—	6.03	6.23	6.04	51.0	55.9	52.9
Tankage	24	—	5.96	6.08	6.11	53.9	53.7	53.4
Fish Meal	26	—	6.20	6.40	5.93	51.8	54.6	53.3
Fish Meal	28	+	6.03	5.92	6.10	51.8	54.4	54.4
Tankage	30	+	5.96	6.08	5.45	52.6	55.3	54.7

From the above represented analysis of the data at hand, it may be stated that the effect on the weight of eggs from the feeding of buttermilk powder, meat meal, tankage, or fish meal, respectively, as the protein concentrate, balanced in the manner described, is negligible.

B. The Relationship between the Presence of Cod Liver Oil in the Diet of Laying Pullets and the Weight of Egg Produced.

In the previous discussion it was suggested that cod liver oil, when supplemented to a ration, might be a factor in increasing egg weight. Table 12 presents data from all rations studied which may serve for a comparison of the weights of eggs from cod liver oil and non cod liver oil diets. The group marked with the plus sign represents those birds which received diets supplemented with two per cent of cod liver oil. The group marked with the negative sign represents those birds which were given no cod liver oil in their diet.

TABLE 12.—*Comparing the diets including cod liver oil with those receiving no additions of cod liver oil.*

2% CLO	No. of Birds	MX Mean maximum body weight (pounds)	MY Mean weight of eggs (grams)	r. Coefficient of correlation Body wgt. Egg wgt.
+	400	6.00 ± .029	53.6 ± .147	0.371 ± .029
—	277	6.10 ± .037	52.9 ± .156	0.625 ± .024
Difference		−0.10 ± .04	0.7 ± .21	

From table 12 it is shown that the addition of cod liver oil to the diet caused a slight increase in the weight of egg produced. This increase, of 0.7 ± 0.21 grams per egg, approaches statistical significance.

While a general effect of cod liver oil in the diet of laying birds is possibly the production of slightly larger eggs, a study of the effects of its addition to the individual diets under consideration would possibly show differences. With this object in view tables 13, 14, 15 and 16 have been constructed.

TABLE 13.—*Showing the effect when cod liver oil is added to a ration of basal plus buttermilk powder.*

Cod Liver Oil in ration	N	MX Mean maximum body weight (pounds)	MY Mean weight of egg (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Present	63	5.89 ± .059	53.7 ± .339	0.262 ± .079
Absent	52	6.14 ± .074	52.9 ± .336	0.465 ± .073
Difference		−0.25 ± .09	0.8 ± .48	

TABLE 14.—*Showing the effect when cod liver oil is added to a ration of basal plus meat meal.*

Cod Liver Oil in ration	N	MX Mean maximum body weight (pounds)	MY Mean weight of egg (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Present	55	6.12 ± .087	53.0 ± 1.075	0.008 ± 0.091
Absent	55	6.11 ± .080	53.2 ± .382	0.600 ± 0.058
Difference		0.01 ± .036	−0.2 ± 1.038	

TABLE 15.—*Showing the effect when cod liver oil is added to a ration basal plus tankage.*

Cod Liver Oil in ration	N	MX Mean maximum body weight (pounds)	MY Mean weight of egg (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Present	52	5.83 ± 0.0652	54.4 ± 0.4208	0.4700 ± 0.0729
Absent	58	6.06 ± 0.0696	52.8 ± 0.3363	0.4782 ± 0.0684
Difference		−0.23 ± 0.094	1.6 ± 0.538	

TABLE 16.—*Showing the effect when cod liver oil is added to a ration of basal plus fish meal.*

Cod Liver Oil in ration	N	MX Mean maximum body weight (pounds)	MY Mean weight of egg (grams)	r. Coefficient of correlation Egg wgt. Body wgt.
Present	57	6.03 ± 0.0795	53.7 ± 0.3209	0.3724 ± 0.0770
Absent	58	6.18 ± 0.0617	53.4 ± 0.2825	0.1510 ± 0.2825
Difference			−0.15 ± .10	03 ± 0.2825

From an examination of the above mentioned tables it appears that the action of cod liver oil on the different protein concentrates was not similar in the intensity with which it affected the weight of egg produced. When cod liver oil was supplemented to tankage in the diet, the effect on increasing egg size was great enough to appear as statistically significant in these data. The effect on the milk diets was similar to that shown by tankage, only less intense. Had the numbers been larger, statistical significance might have been found. The work of McFarlane, Graham and Richardson (*17*) has shown that the fish meal used in these diets was comparatively rich in vitamin D. With this in mind the small effect of cod liver oil in increasing the weight of eggs from birds on a fish meal concentrate diet is not surprising. Just why cod liver oil had no effect in raising the egg weight, when supplemented to meat meal diets, cannot be explained from our present knowledge.

With respect to the relationship between body weight and egg weight, the results from the diets that contained fish meal as the protein concentrate, are of particular interest. This concentrate seemed to behave in a different manner to the others. When fish meal was fed unsupplemented by cod liver oil the correlation between body and egg weight was insignificant. When supplemented with cod liver oil an almost significant correlation was shown. When milk and fish meal were fed unsupplemented by cod liver oil in the diet, a very strong relationship between the factors under consideration existed. This correlation was destroyed by the addition of cod liver oil to the diet, as shown by the data from Pen 8. Proof has been given that the fish meal used in this experiment contained considerable quantities of Vitamin D. The fact that the milk and fish meal pen, unsupplemented by cod liver oil, gave such a high correlation could be accounted for by the presence of relatively large amounts of the anticalcifying factor of Mellanby in the oat and corn base to the diet. Vitamin D then might be shown to be the factor which destroyed the correlation between egg and body weight. Unfortunately, however, Pen 2, which received thirty minutes' irradiation with ultra violet light daily except Sundays, showed a high value for r. This would indicate that Vitamin D was not the factor that destroyed the coefficient of correlation between body weight and egg weight.

C. The Effect of Cod Liver Oil in the Diets of Laying Pullets on the Value of the Coefficient of Correlation between Mean Maximum Body Weight and Mean Egg Weight.

Large fluctuations in the value of this coefficient of correlation were noted in previous observations on table 5. In these data the value for r. is shown to change according to the diet from 0.008 to 0.945.

The data presented in tables 6, 7, 8, 9, and 10 tend to show that at least the protein concentrates—buttermilk powder, meat meal, and tankage—have little effect in themselves on the value of the coefficient under discussion. Table 14 showed the value of r. when the birds were fed on rations containing cod liver oil to be 0.371 $\pm$ .029. When cod liver oil was not fed to birds otherwise receiving similar diets, the value of the coefficient of

correlation between egg and body weight (r) rose to 0.625 ± .024. Similarly tables 13, 14 and 15 showed that the addition of cod liver oil to a diet tended to destroy the correlation between egg and body weight when milk or meat meals are fed as the protein concentrates. There seemed to be little or no effect when tankage was fed as the protein concentrate.

It appears that factors other than Vitamin D may be responsible for the reduction of the value of the correlation between body and egg weight when cod liver oil is fed in the diet. The basal diet fed to all birds contained seven parts of yellow corn, ten per cent of alfalfa leaf meal, and one-half of one per cent of iodized salt. A diet of this nature should be amply fortified against deficiencies in either Vitamin A or Iodine, without the addition of cod liver oil. That the addition of two per cent of fat in the form of cod liver oil was the factor in destroying this relationship is hardly compatible with the knowledge of the known fat contents of the various diets.

Hauge, Carrick and Prange (*12*) have shown that twenty-five per cent of yellow corn in the diet satisfied the demands for Vitamin A for growth in domestic fowl. Many times this amount of Vitamin A must have been present in the basal diet which was fed to all birds. While this fact must have excluded Vitamin A deficiency as a factor, even in reproduction, it introduces the possibility of an hypervitaminosis A as being the factor destroying the relationship under discussion when two per cent of cod liver oil was added to the diet. If such a condition exists in fowl, little or nothing is known about it at the present time.

Besides the above mentioned factors, cod liver oil contains a number of the more highly unsaturated fats and other ether extractible products which the bird may not be able to synthesize. It is worthy of note that relatively large amounts of cholesterol and lecithin are among these substances. Both of these compounds are essential requirements in the formation of the egg. It is, however, beyond the scope of the data gathered from this experiment to study the effect of these factors on the results obtained.

As shown above, the variations in the numerical values given, the relationship between egg and body weight would have been attributed to the effect of increased amounts of Vitamin D in the diets had the reactions of Pen 2 to ultra violet light been similar to those initiated by the addition of cod liver oil to the diet. Similar results were, however, not attained. The fact that the mercury quartz lamp used in irradiation was tested at intervals throughout the experiment for its ability to produce the required intensity of light in the ultra violet and that the use of this means of supplementing the diet with Vitamin D showed marked improvements in hatchability of the eggs produced in Pen 2, assures us that the birds so treated were subjected to light of the proper wave lengths. From these facts it would appear unlikely that Vitamin D was the direct cause of the destruction of the correlation between egg and body weights of domestic fowl when cod liver oil is added to the diet under the conditions of this experiment. A point of interest, however, arises from the technique in the application of the ultra violet light. The lamp employed

was situated in a heated building some seventy-five yards from the quarters occupied by the birds. Before each irradiation the twenty birds composing this pen had to be caught, placed in a crate, and transported to and from the lamp. In spite of precautions taken, the birds became somewhat frightened during their capture until they became well accustomed to this procedure. In addition, these pullets were subjected to very rapid changes in temperature when they were thrust back in the cool pen during the winter months, after spending the previous half hour under the heat of a mercury arc lamp. Treatment of this nature could hardly be expected to be without physiological effects.

In the general observations of practical poultrymen it has been found that frightening the birds in a pen will cause a decrease in egg production. The effect of rapid changes in temperature is often very marked in decreasing the numbers of eggs laid. Reliable experimental evidence has not been found in the literature to either prove or disprove these observations which are so widely accepted as fact among those with practical experience with poultry.

Table 17 has been constructed to show the percentage hatch and total production for eleven months of each year in comparison with the data already studied in this paper. These additional data have been taken from the results of Graham, Smith and McFarlane (*8*) who worked with the same records from which the data presented in this paper were obtained.

TABLE 17.—*Showing comparison of value of correlation without factors.*

Ration	Correlation Egg wgt. Body wgt.	Hatch %	Production
Milk, Fish	.9465	49.1	141
Milk, Irradiation	.7320	74.4	139
Meat	.6003	43.6	138
Cod, Tankage, Milk	.5664	60.2	151
Tankage	.4782	22.8	126
Cod, Tankage	.4700	32.0	157
Milk	.4657	57.0	143
Cod, Fish	.3724	57.5	177
Cod, Meat, Milk	.3259	70.8	165
Cod, Fish, Milk	.2904	68.4	166
Cod, Milk	.2624	67.7	153
Fish	.1510	56.3	165
Cod, Meat	.0085	65.2	164

Nutritionally, Pens 2 and 4 are strictly comparable with regard to the effects of Vitamin D. It has been noted that the birds which were subject to ultra violet light showed a much greater relationship between the body weights and egg weights than did those receiving Vitamin D from cod liver oil. It is also apparent that Pen 4, which received cod liver oil in the diet, showed an increase of fourteen eggs in annual production over that of Pen 2. From previous discussion this difference in production may be attributed to the technique employed in irradiation.

Tables 18, 19, and 20 have been constructed from the data presented in table 17 to show the relationship between the value of r. as represented

and total egg production; the value of r. and the presence of cod liver oil in the diet; and between the total egg production and the presence of cod liver oil in the diet. The method used is that of Yule (*25*). The data gathered from Pen 2 have been excluded from the following analytical tables on the ground that the production of this group of birds may not be compared with the other pens on an equal basis.

TABLE 18.—*The relation of increased production—over 150 eggs in eleven months—to the value of r.*

PRODUCTION.

		Over 150 eggs	Under 150 eggs	
Value of r.	Over 0.4	2	5	7
	Under 0.4	6	0	6
		8	5	

$$\text{Coefficient of association} \quad \frac{0\times2 - 6\times5}{\sqrt{5\times6\times7\times8}} = \frac{-30}{\sqrt{1600}} = -0.75$$

TABLE 19.—*The relation of increased production—over 150 eggs in 11 months—to the presence of Cod Liver Oil in the diet.*

PRODUCTION.

		Over 150 eggs	Under 150 eggs	
Cod Liver Oil in diet	Present	7	0	7
	Absent	1	4	5
		8	4	

$$\text{Coefficient of association} \quad \frac{7\times4 - 0\times1}{\sqrt{4\times5\times7\times8}} = \frac{28}{\sqrt{1120}} = 0.90$$

TABLE 20.—*Relation of Cod Liver Oil in diet to value of r.*

		r. over 0.4	r. under 0.4	
Cod Liver Oil in diet	Present	2	5	7
	Absent	4	1	5
		6	6	

$$\text{Coefficient of association} \quad \frac{2 - 20}{\sqrt{6\times5\times5\times7}} = \frac{-18}{\sqrt{1050}} = -0.5$$

In table 19 strong evidence is presented to show that a positive association existed between the presence of cod liver oil in the diet of the laying birds and increased production (over 150 eggs). This finding is in accordance with that of Hopper (*13*). The only diet from which increased production was obtained, to which supplementary additions of

cod liver oil were not made, was that in which fish meal was fed as the sole protein concentrate. Since fish meal contains appreciable amounts of the anti-rachitic factor, the evidence points toward Vitamin D as the substance which caused increased egg production under the conditions of this experiment.

The results shown by table 18 indicate that there was a relatively strong negative relationship between increased production and the magnitude of the coefficient of correlation between the weight of bird and the weight of egg produced; in other words, that when the production tended to rise above one hundred and fifty eggs for the eleven months' period the relationship between body and egg weights tended to decrease toward insignificance. The relationship between the presence of cod liver oil in the diet and the magnitude of the correlation in question, as shown in table 20, was similar to that found between the value of r. and increased production, though less intense.

From the above analysis of the data at hand it appears that the presence of Vitamin D tended to cause increased production when cod liver oil was added to the diets. The relationship of 0.90 between these two factors was probably only prevented from being perfect by the presence of a Vitamin D carrying protein concentrate, which gave increased production without the presence of cod liver oil in the diet fed. The coefficient of correlation between the mean maximum weight of bird and the mean weight of egg was shown to be negatively associated with both increased production and the presence of cod liver oil in the diet. The values of —0.75 and —0.50 for these associated characters tend to show that the increased production produced a more intimate effect on the correlation than did the presence of cod liver oil in the diet. Thus the effect of the presence of cod liver oil in the diet on the reduction of the coefficient of correlation under discussion was perhaps more or less secondary in nature. Summing up the evidence it seems that the presence of cod liver oil in the diet caused increased production through the presence of Vitamin D. This increased production in turn tended to destroy the value of the correlation between egg weight and body weight.

In conclusion, it must be stated that the evidence presented is far too meagre to offer the above hypothesis as proven in any manner. That many factors, other than Vitamin D or increased production may be partially or wholly the cause of the destruction of the coefficient of correlation between body and egg weight has been shown before.

Conclusions

From the data gathered from the records of 913 Barred Plymouth Rock Pullets, analysed as shown above, the following conclusions have been reached:

1. A positive and significant correlation exists between the maximum body weight obtained by Barred Plymouth Rock pullets for the six months' period, February to July inclusive, and the mean weight of their eggs laid during the same period.

TABLE 21.—*Correlation of egg and body weights for the year 1929.*

BODY WEIGHT IN POUNDS.

EGG WEIGHT IN GRAMS	3.625	3.875	4.125	4.375	4.625	4.875	5.125	5.375	5.625	5.875	6.125	6.375	6.625	6.875	7.125	7.375	7.625	7.875	8.125	8.375	8.625
69.5																					
68.5															2						
67.5												2									
66.5										1	1		1								
65.5											1			1							
64.5											1	2	1	1	2						
63.5									1		1	2	1		1				1		
62.5							1	1	3	4	4	1	5	3		2				1	
61.5								1	3	5	5	3	4	2	1		1			2	
60.5					2	1		4	2	6	1	2	4	3	7	3	4				
59.5						2	1	5	4	6	10	8	6	5	2	2		1			
58.5		1		2		1		2	8	3	8	5	10	3	8	4					
57.5				1	2	6	3	10	15	10	8	9	8	4	9	5	3	1			
56.5					5	1	9	11	13	8	10	3	7	7	8	5	2	3		2	1
55.5				1	6	3	16	19	18	11	14	10	7	8	8	2	5	2	2		
54.5					5	11	10	21	17	13	11	14	11	6	6	4	4	2	3	1	
53.5	1	1	1	1	10	10	11	21	13	20	19	9	11	6	5	4	3	1			
52.5			2	4	19	7	18	15	19	19	21	7	14	10	3	2		1		2	
51.5			2	5	14	12	14	21	17	9	22	20	4	3	1	1	2	4		1	
50.5		2	1	5	16	10	9	5	15	13	19	8	3	2	1	3	2	1			
49.5			2	6	10	9	14	8	12	11	7	7	2		2						
48.5	2	1	1	4	9	5	10	6	13	6	5	6	3	1		1					
47.5			2	4	5	2	10	2	4	9	6	3	1	1	1						
46.5		1	3	3	3	4	8	1	4	1			1		1	2					
45.5		1			1	1		4	2	3	1										
44.5							1			1	1										
43.5									1	1											
42.5								2													
41.5							1	1		1											
40.5									1												
39.5								1													
38.5						1															
37.5								1													

2. The weight of pullet for any one month is a less reliable index of her egg weight than is the maximum weight attained during the months of February to July inclusive.
3. A positive and significant correlation was found which showed a very close relationship between the weight of egg set and the weight of chick hatching from the same egg.
4. An indication was found that within normal bounds the weight of egg has little or no effect on its hatchability.
5. From the data presented no relationship was shown between the various protein concentrates fed and the size of egg produced.
6. The presence of cod liver oil in the diet of laying pullets caused a slight increase in egg weight during the months of February to July inclusive under these conditions of experiment.
7. The presence of cod liver oil in the diet tends to destroy the coefficient of correlation between egg and body weights under the conditions of this experiment.

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CURRENT PUBLICATIONS

56. Marketing Principles. J. F. Pyle. Available from Department of Agriculture Library, Ottawa.

It is rather a dull day in the publishing business that does not bring forth a new book on some phase of the problem of marketing. Just why this is the case and the increasing importance of marketing is set forth in the opening chapters of Pyle's book on marketing principles.

This book, as the title suggests, is not limited to the discussion of any one phase of the field of marketing. The principles of marketing, applicable to any commodity, are drawn from a survey of the whole field. Herein lies the strength of this work as it allows a comparison of the different methods and degrees of success attained by the diverse methods of marketing various commodities

The survey of the entire field of marketing including natural products, the agricultural group, manufactured goods and services, comprises over five hundred pages, divided into twenty chapters. This treatment includes first a discussion of the ever changing condition of the people, their purchasing power and buying habits. Next comes a discussion of marketing functions, methods and organization. Then follows a treatment of marketing practices, while finally follows marketing problems, including standards of marketing efficiency.

The necessity is stressed of investigating what the market will absorb in order to know what and how much to produce. In support of this is mentioned the fact that the motor manufacturers have (particularly since 1924) kept production in line with demand, while the surpluses of sugar, cotton, coffee and wheat have been troublesome since 1921 on account of neglect of this point.

While the whole field of marketing is included, two chapters are devoted to the marketing of agricultural products. These products are frequently used as examples throughout the work and the cooperative method of marketing farm products, together with a presentation of the aims and organization of the Federal Farm Board is included. Hence much valuable material will be found by those interested particularly in this special field. The discussion of the marketing of farm products is more of a presentation of facts than a criticism of practices.

The numerous questions and problems presented with each chapter make this a suitable text for those desiring a survey of the whole field. And the field as presented here is by no means cramped, as over-production, potential or actual; the struggle for markets; installment buying; and tariffs are treated as factors in influencing present business conditions.

Not the least valuable part of this work is the claim that we do not yet know whether our marketing system is efficient or not as we have not as yet the standards necessary by which to decide, and insistence on the necessity for research in marketing.

Condensation is achieved and interest maintained in this comprehensive treatment of present marketing practices.

—J. E. L.

STATUT ACTUEL DE LA PRODUCTION DE LA GRAINE DE TREFLE ROUGE AU CANADA, AVEC REFERENCE SPECIALE AUX COMTES DE PRESCOTT ET RUSSELL, ONT.[1]

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La production de la graine de trèfle rouge au Canada a dans le passé, presque toujours été insuffisante pour rencontrer la demande.

La classification de la graine de trèfle rouge par le Bureau fédéral des statistiques du ministère du Commerce et de l'Industrie remonte seulement à 1928 et depuis, tous les ans, les importations ont excédé de beaucoup les exportations. L'on importait en 1929 environ 1,298,000 livres, 615,000 livres en 1930 et 1,795,000 livres en 1931, la presque totalité de ces quantités venant de France, Etats-Unis, Angleterre et Nouvelle-Zélande. Durant cette même période les consignements destinés à l'étranger s'élevaient à 45,060 livres en 1929, 10,800 livres, en 1930 et à 304,080 livres en 1931. Les volumineuses importations et exportations rapportées pour 1931 peuvent apparemment paraître anormales; elles s'expliquent cependant. Presque toutes les importations de 1931 furent faites au début de l'année, avant les ensemencements, pour combler le déficit de la production domestique de 1930, tandis que les exportations comprennent une partie du surplus de la récolte de 1931, déjà en mouvement avant la fin de l'année. Depuis la dernière récolte il n'y a pas eu d'importation et à date les exportations ont dépassé 1,000,000 livres.

On ne peut encore qu'estimer la quantité totale de graine de trèfle rouge produite au pays en 1931, néanmoins l'on sait que c'est une des grosses récoltes obtenues depuis bien des années, pouvant dépasser quatre millions de livres. Les plus grosses augmentations proviennent de l'Est de l'Ontario et de Québec. La qualité en général est exceptionnellement bonne, à l'exception peut-être de quelques districts du sud-ouest de l'Ontario, où des graines plus petites sont rapportées, à cause de la grande sécheresse.

L'emploi de semences plus acclimatées, la condition des champs de trèfle au printemps et la température de l'automne dernier convenant admirablement bien pour cette production ont été les facteurs favorisant de gros rendements de haute qualité. L'abondance de foin et les bas prix en perspective ainsi que l'application d'un tarif de trois cents sur la graine importée à l'exception de celle venant des possessions Britanniques ont contribué dans une large mesure à inciter le cultivateur à conserver une plus grande étendue en vue de la production de la graine de trèfle rouge.

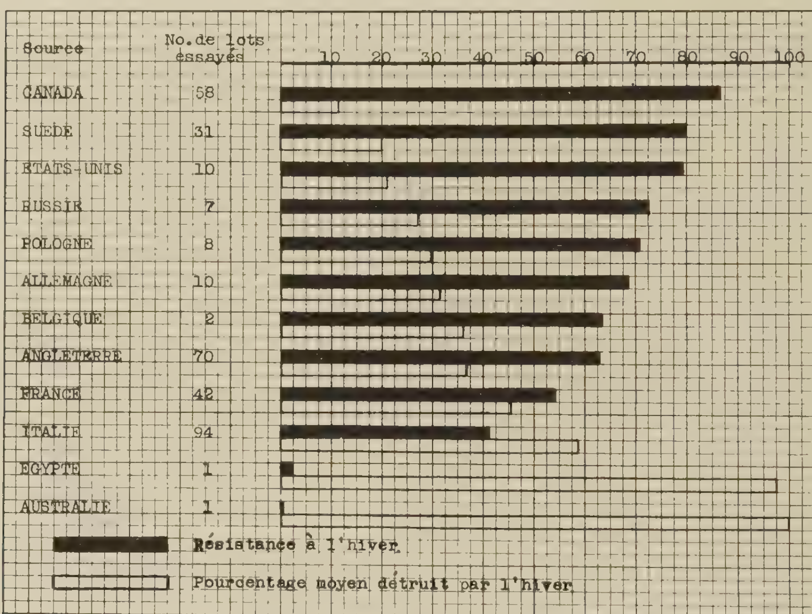
L'influence de l'origine de la semence sur la rusticité du trèfle rouge.

Lors d'une conférence tenue à Copenhague en juin 1921 il fut démontré, preuves expérimentales à l'appui, que la graine de trèfle rouge venant des régions du sud ne convenait pas pour le nord, parce que n'ayant pas une résistance suffisante à l'hiver.

1 L'auteur désire exprimer ses sincères remerciements au Dr. T. W. Grindley, Chef de la Statistique agricole, et M. L. E. Kindt, Economiste agricole pour les nombreuses informations qu'ils ont obligeamment fournies lors de la préparation de ce travail.
2 Inspecteur.

Devant ces faits, bien des pays d'Europe limitèrent rapidement l'importation de graine de trèfle rouge non rustique. Les Etats-Unis adoptèrent peu après des mesures similaires, affectant principalement la graine qui venait de l'Italie et des autres pays du sud.

Les essais de rusticité conduits à la Ferme Expérimentale Centrale, Ottawa, de 1923 à 1927, rapportés par McRostie (*1*) et dont les résultats obtenus ont servi à présenter le graphique 1, fournissent une bonne indication de la valeur des différentes provenances de la graine qui doit être semée sous nos conditions. Il faut remarquer que sur les 58 lots employés comme provenant du Canada plusieurs étaient d'introduction assez récente sous notre climat. La résistance à l'hiver eut été encore plus marquée si les lots choisis n'avaient représenté que des souches cultivées ici depuis longtemps.



Graphique 1.

L'influence marquée de l'origine de la graine sur la résistance des trèfles se fait naturellement sentir avec la même intensité sur les rendements. Baird (*2*) en 1927 rapporte 5 lots originaires du Sud de l'Europe comme produisant un rendement-foin moyen de 0.98 tonne par acre en comparaison avec une récolte de 3.2 tonnes fournies par 4 lots de lignée canadienne.

En plus de la rusticité une autre différence entre le type de trèfles Européen et Canadien est l'adaptabilité de ce celui-ci de pousser sous nos étés très chauds. Règle générale, en vue de la production de la graine, l'on doit effectuer la première coupe lorsque la seconde pousse apparaît au collet de la plante, ce qui arrive le plus souvent vers la troisième semaine de juin, renvoyant ainsi la végétation de la seconde récolte en juillet et

août. C'est aussi à cette époque que l'on a les journées les plus chaudes et sèches de l'été. Tandis que le type Canadien velu va prospérer et produire une récolte sous ces conditions de chaleur excessive, les trèfles du type Européen seront généralement brulés.

Au Canada, la loi des semences en vigueur depuis 1905 fut revisée en 1923; l'on inséra alors une clause spéciale concernant la coloration et régissant l'importation des graines de trèfle et de luzerne, évitant ainsi que le Canada devienne le dépotoir pour toute la graine de trèfle rouge non rustique. Quelques amendements dans les règlements furent apportés par la suite, et en 1928 l'on adopta les mesures législatives en vigueur aujourd'hui (*3*) et qui prescrivent que toute graine de trèfle rouge ou tout mélange contenant au moins 10 pour cent sera coloré selon sa provenance a) des Etats-Unis 1 pour cent bleu marin, b) de tout autre pays 1 pour cent vert, c) de l'Amérique du Sud, Italie, Afrique ou une partie du Turkestan 10 pour cent rouge.

La coloration est effectuée par les inspecteurs de la Division des Semences ou les importateurs sous la surveillance des percepteurs du Revenu National et sur preuves relatives au pays d'origine. C'est donc là une protection réelle permettant au cultivateur de s'assurer rapidement de l'identité d'origine de la semence de trèfle rouge qu'il achète.

Classification des trèfles rouges.

Suivant les caractères morphologiques de la plante et le mode de végétation, on peut placer les trèfles rouges sous quatre groupements principaux. Les caractères morphologiques indiquent qu'ils peuvent être classés en type velu ou type Canadien et lisses ou velus appressés ou type Européen (figures 1 et 2). Le mode de végétation permet de le diviser en type dit Mammoth ou à coupe simple et à deux coupes suivant qu'ils produisent une ou deux coupes la même saison.

L'observation des essais conduits par la division de l'Agrostologie à Ottawa a révélé que la résistance à l'hiver est étroitement associée avec la présence de petits poils sur les tiges et les feuilles ainsi qu'une coloration vive et prononcée des fleurs. Ces essais indiquent de plus que les lots possédant ces caractères morphologiques étaient presque toujours d'origine canadienne. Cependant bien que ces caractéristiques indiquent des qualités de rusticité il faut remarquer qu'il n'est pas possible d'assumer en toute sureté que tous les trèfles du type lisse ne sont pas résistants à l'hiver. Les récoltes dont la souche remonte au type Suédois-hâtif ou tardif à tiges lisses peuvent se comparer avec le trèfle canadien du type velu. Cette lignée n'est guère répandue et ces cas se rencontrent si rarement que le travail de certification du trèfle rouge, en ce qui concerne le type, repose sur ces données. Afin de déterminer l'influence de l'origine de la graine sur le type (velu ou lisse) nous avons entrepris en 1931, au cours d'inspection dans les comtés de Prescott, Russell et Glengarry un relevé détaillé couvrant 154 fermes. Les producteurs de graine de trèfle de ce district qui achètent leur semence chez le marchand ne sont pas nombreux et c'est pourquoi, dans un but de comparaison nous avons dû en préparant le tableau 1 ramener à 15 le nombre de fermes par groupe.

Tableau 1—*Relation entre l'origine de la graine de trèfle rouge et la proportion de plantes velues.*

	Groupe 1	Groupe 2
Nombre de cultivateurs	15	15
Superficie moyenne en trèfle par ferme	16.4	12
Nombre employant leur propre semence	11	7
Moyenne d'années cultivé sur la ferme	8	4
Nombre ayant obtenu en 1930 leur semence d'autres cultivateurs	4	—
Nombre ayant acheté en 1930 leur semence chez le marchand	—	8
Pourcentage moyen de trèfle velu	83.0%	59.4%
Plus fort pourcentage trouvé	90.0%	75.0%
Plus faible pourcentage trouvé	75.0%	10.0%*
Pourcentage moyen de trèfle lisse et Mammoth	17.0%	40.6%

*Ce trèfle semble se rattacher au type tardif Suèdois importé en 1910 par Mr. Geo. H. Clark, Commissaire des Semences et bien que produisant des récoltes passables dans l'Ouest Canadien ne peut pas être considéré comme éligible pour certification sous la dénomination de trèfle rouge velu du type à deux coupes.

Groupe 1 comprend les fermes où à l'origine, aussi loin que l'on peut retracer, la graine provient du district.

Groupe 2 désigne les fermes où à l'origine, quelquefois l'année même du semis, on remonte aux achats au magasin. Presque tous les marchands du district offrent au choix, de la semence produite localement et de l'-importée. S'il n'y avait pas cette raison la différence dans le pourcentage de trèfle velu entre le groupe 1 et 2 eût été encore beaucoup plus marquée.

L'autre variété de type est le Mammoth, tardif et à coupe unique, lequel paraît convenir le mieux pour les régions du Canada où la saison n'est normalement pas assez longue pour que l'on puisse obtenir deux coupes de trèfle. Dans quelques cas on l'emploie avec avantage en vue de la production du foin, spécialement lorsque la superficie à faucher est considérable, permettant alors de repartir la fenaison sur une plus longue période.

Il est impossible de séparer la graine de trèfle Mammoth de celle de trèfle rouge à deux coupes et difficile de distinguer des différences suffisamment marquées dans l'apparence des plantes si ce n'est que le trèfle du type à coupe unique en comparaison avec le trèfle canadien à deux coupes, est de trois semaines à un mois plus tardif. Le trèfle tardif, à une coupe, ne repousse guère après avoir été coupé une fois. Il produira des feuilles mais en aucun cas des fleurs et c'est là le meilleur moyen d'identification.

On comprend que le cultivateur de Québec ou Ontario qui veut se procurer de la graine de trèfle ordinaire comptant obtenir le type hâtif à deux coupes, perd beaucoup s'il arrive que la semence qu'il reçoit appartient au type Mammoth, surtout s'il compte sur la deuxième pousse pour la production de la graine.

Certification de la graine de trèfle rouge Canadien velu à deux coupes.

L'introduction par la Division des Semences, de la graine de trèfle rouge certifiée comme trèfle canadien velu, du type à deux coupes comble cette lacune. Lors de l'inspection sur pied en vue de la certification,

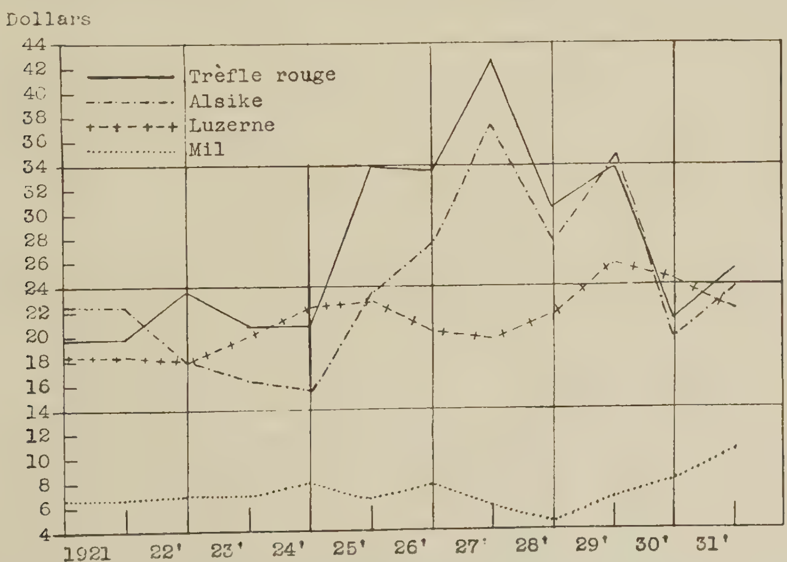
on détermine le dégré de résistance tel que montré par la vigueur des plants, la couleur des fleurs et le pourcentage de plantes velues, lequel ne doit pas être inférieur à 70 pour cent, de même que la resistance à l'hiver qui doit être d'au moins 75% ainsi que l'absence totale de la silène enflée. Attention spéciale est donnée aux mauvaises herbes dont la grosseur et la pesanteur des graines les rendent de séparation difficile lors du nettoyage de la semence. Ces mauvaises herbes communes au trèfle rouge en général sont par ordre de fréquence dans le district auquel nous référons plus particulièrement.

Sétaires	(*Setaria viridis* & *Glauca*)
Grande herbe à poux et herbe à poux commune	(*Ambrosia trifida* & *Ambrosia artemsiifolia*)
Chicorée	(*Cichorium Intybus*)
Silène noctiflore	(*Silene noctiflora*)
Plantain lancéolé	(*Plantago lanceolata*)
Lupuline	(*Medicago lupulina*)
Patiences	(*Rumex* spp.)
Trèfle d'odeur	(*Melilotus* spp.)

On appuie aussi sur l'éradication des mauvaises herbes primaires dangereuses, telles que silène enflée (*Silene latifolia*) et moutarde sauvage (*Brassica arvensis*).

Fluctuations des prix de la semence.—

Les cotes fournies par les marchés de semences de Toledo, Chicago, Kansas City et autres marchés d'exportation ainsi que la production totale domestique sont les facteurs qui influent grandement, chaque année au Canada sur le cours des prix de vente de la graine de trèfle rouge. C'est

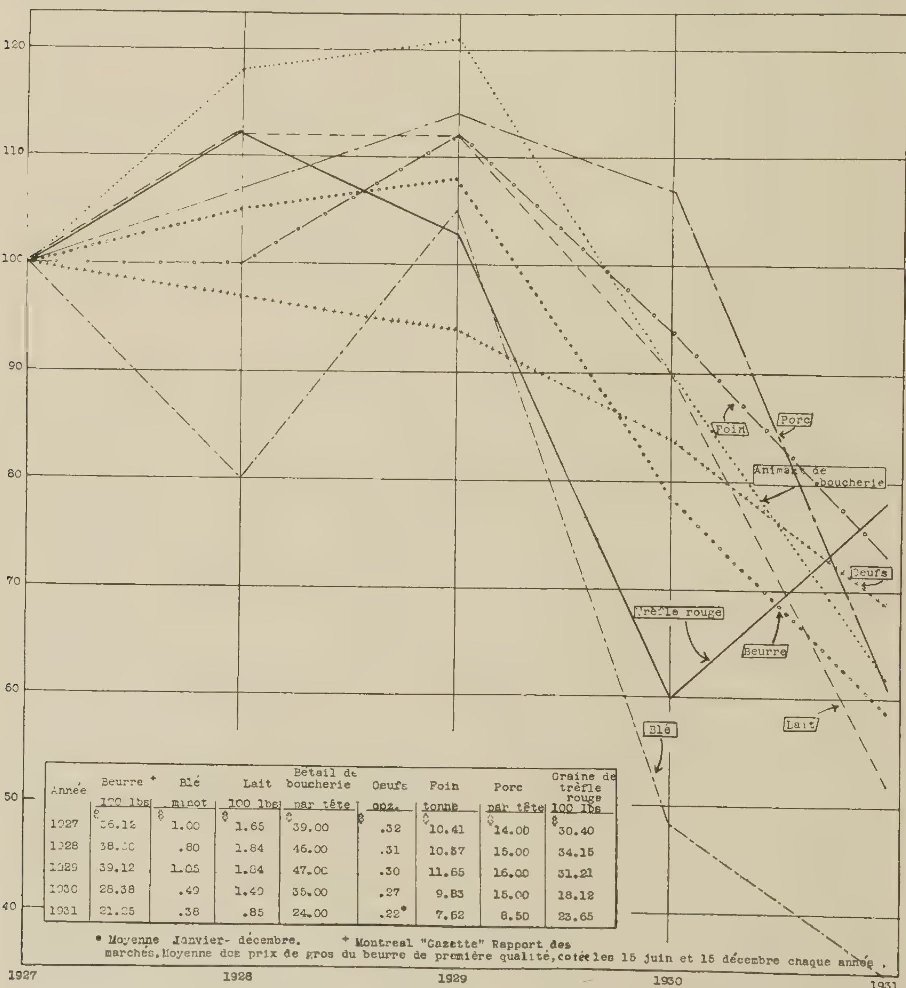


Graphique 2. Fluctuation des prix de gros pour les semences de première qualité à Chicago et Kansas City, 1921-1931.

la semence dont la valeur, comparée avec celle de la luzerne, trèfle d'alsike et mil, semble répondre le plus rapidement à une hausse tout en conservant un prix moyen.

La valeur de ces graines fourragères telle que compilée par le Bureau de l'Economie rurale du Ministère de l'Agriculture des Etats-Unis (*4*) a servi à la préparation du graphique 2 lequel montre les fluctuations des prix de gros depuis les derniers dix ans à Chicago pour les trèfles rouge, d'alsike et mil et les variations de prix à Kansas City pour la luzerne.

Comparés avec les prix des autres produits de la ferme ceux de la graine de trèfle rouge montrent une stabilité beaucoup plus prononcée. L'information servant de base au graphique 3 a été fournie par le Bureau



Année	Beurre + 100 lbs	Blé minot	Lait 100 lbs	Bétail de boucherie par tête	Oeufs doz.	Foin tonne	Porc par tête	Graine de trèfle rouge 100 lbs
1927	$ 36.12	$ 1.00	$ 1.65	$ 39.00	$ .32	$ 10.41	$ 14.00	$ 30.40
1928	38.00	.80	1.84	46.00	.31	10.87	15.00	34.15
1929	39.12	1.05	1.84	47.00	.30	11.65	16.00	31.21
1930	28.38	.49	1.49	35.00	.27	9.83	15.00	18.12
1931	21.25	.38	.85	24.00	.22*	7.62	8.50	23.65

* Moyenne Janvier- décembre. + Montreal "Gazette" Rapport des marchés. Moyenne des prix de gros du beurre de première qualité, cotée les 15 juin et 15 décembre chaque année.

Graphique 3. Nombres-indices des prix moyens payés aux cultivateurs pour différents produits de la ferme, et comportement de la graine de trèfle rouge en rapport avec ces fluctuations. Période de 5 ans.

Il est a remarquer que les prix du blé, lait, beurre, oeufs, animaux de boucherie, porc et foin ont considérablement déclinés en 1930-31, et bien que la semence de trèfle ait parallélement diminuée, l'on constate en 1931 une substantielle avance.

Fédèral de la Statistique et les chiffres donnés * représentent la moyenne des prix payés aux cultivateurs à l'exception du beurre dont la valeur indique les prix de gros fournis par "The Montreal Gazette". L'estimation des prix moyens payés aux cultivateurs, par tête d'animaux de boucherie et les porcs pour l'année 1931, est fournie par la Division Fédérale de l'Industrie animale.

A cause de la diversité des produits, afin d'obtenir une meilleure compréhension dans la comparaison des prix, il a été utile d'exprimer en nombres-indices les valeurs actuelles données au tableau inclus au graphique et, dans ce but l'année 1927 fut choisie comme representant la normale. En considérant la fluctuation des prix de la graine de trèfle il faut se rappeler que c'est une production spéciale (side-line) en même temps qu'une récolte à revenu immédiat (cash-crop).

En vue de connaître le prix de revient de la graine de trèfle rouge des formules spécialement préparées furent remises au printemps 1931 à une vingtaine de cultivateurs des comtés de Prescott, Russell et Stormont. Le loyer de la terre, l'emploi des machines ont été déterminés suivant une valeur arbitraire. La valeur de la semence utilisée, la récolte de la graine de trèfle, le coût du battage et du criblage constituaient les items individuels à débiter. Aucun de ces producteurs ne fait emploi d'engrais chimiques et l'on a négligé de calculer la valeur de la part du fumier applicable au trèfle admettant qu'elle est amplement contrebalancée par la paille obtenue au battage dont on peut tirer un excellent parti sur la ferme. Les décortiqueuses sont opérées le plus souvent dans ce district par un syndicat. Le nettoyage de la semence s'effectue généralement au centre de criblage.

Dix-sept coûts de production complétés, couvrant la dernière récolte indiquent un prix de revient moyen de $10.55 par 100 livres. Le coût le plus bas étant $7.00 et le plus haut $15.00. Le rendement moyen est de 130 livres à l'acre avec des extrêmes de 75 et 240 livres. Le rendement à l'acre, le coût du battage, qui dans certains cas s'élèvent jusqu'à 5 et 6 cents la livre, et la densité du semis ont été trouvés comme les principaux facteurs déterminatifs de la variation des prix de revient.

La production dans Prescott et Russell depuis les derniers dix ans.

Situés à l'extrême Est de la province d'Ontario, limités par la rivière Ottawa au nord, avoisinant la province de Québec à l'est, entourés des comtés de Glengarry, Stormont et Dundas au sud, et de Carleton à l'ouest, les comtés de Prescott et Russell avec une latitude de 45° 15′ à 45° 40′, sous la longitude 74° et 75°, ont une superficie totale de 491,255 acres dont 319,914 en culture.

Pratiquement toute cette surface repose sur des sédiments rocheux. (Black River et pièrre à chaux de Trenton), vingt-cinq pour cent consistent en une couche de sol extrêmement mince avec de fréquents effleurements de cette pièrre à chaux. L'action des agents extérieurs et les résultats chimiques provenant de la désagrégation et de la décomposition de ces effleurements ont de très importants effets sur la fertilité du sol et la végétation des plantes. On rencontre aussi disséminés par toute l'étendue des dépots de l'époque glacière contenant du sable, du gravier et des cail-

*Les prix du trèfle rouge sont donnés par période fiscale d'avril à mars inclusivement.

loux de différentes dimensions, lesquels influent sur le type de sol et les pratiques culturales.

C'est une région à petites ondulations avec de grandes plaines à base d'argile, le drainage s'effectuant principalement vers la rivière Ottawa. A proprement parler il n'y a pas de montagne, les élévations de terrain avoisinant 150 à 300 pieds au dessus du niveau de la mer et d'après Jarvis (5) la température diminuant de 1° pour chaque 300 pieds d'élévation, l'on voit que sous ce rapport il n'y a pas lieu de s'inquièter de la distribution des récoltes.

La saison de végétation est d'environ 150 jours. La précipitation en 1931 pour les 5 mois formant la saison de végétation fut de 10.81 pouces; la plus forte précipitation soit 3.94 pouces enregistrée en septembre et la plus faible soit 0.41 pouce en août (*6*).

Jusqu'en 1923 les comtés de Prescott et Russell, étaient regardés comme un centre de production de foin de mil. Une culture de trèfle était considérée comme une récolte incertaine parce que l'on employait alors des semences importées ou d'origine douteuse.

Retracer le développement de la production jusqu'à l'origine, c'est remonter à l'arrivée de l'agronome F. Larose dans les Comtés-Unis de Prescott et Russell. La diminution considérable de la fertilité du sol, due à une culture constante et excessive de foin de mil, devenait un sérieux problème. Il s'agissait de changer le système de culture, de diminuer l'étendue en mil et d'introduire une plante capable de regénérer la fertilité du sol et apte à produire un excellent fourrage pour les animaux laitiers. Le trèfle rouge moyen à deux coupes choisi comme devant remplir ces conditions fut recommandé et afin d'assurer le succès des récoltes futures l'on entreprit la production d'une semence de trèfle rustique. C'était là

Figure 1. Plante de trèfle rouge montrant la nature velue, caractéristique du trèfle canadien typique.

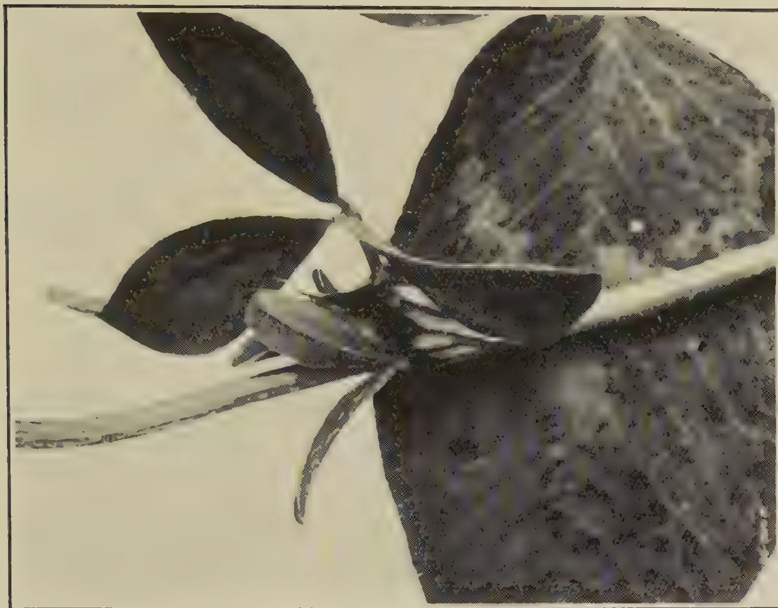


Figure 2. Plante de trèfle rouge montrant tiges et feuilles à surface lisse, caractéristique du trèfle européen typique.

le point de départ d'une production qui devait en 1931 contribuer pour plus du quart de la récolte totale de l'est de l'Ontario (ouest de Toronto), estimée à 2,000,000 livres. Puis vint l'éradication des mauvaises herbes et enfin l'organisation de centres de criblage disséminés aux endroits stratégiques. Les deux comtés sont aujourd'hui dotés de neuf stations possédant une ou plusieurs unités de nettoyage tels que crible genre "Clipper", trieur Marot, Carter disc, et ébarbeuse à orge. Et pour terminer, l'Association des Producteurs de Grains de semence de Plantagenet" fondée en 1928, organisée dans un but coopératif, dirigée par l'agronome, surveille le qualité, l'uniformité du produit et la classification de la semence. A cette Association revient le privilège d'avoir préparé le premier "wagon" de trèfle certifié offert en vente au Canada. "L'Association Canadienne des Producteurs de Semences" est présentement à considérer l'enregistrement de quelques lignées de trèfle ayant montré des qualités vraiment supérieures.

La récolte de 1931 est reconnue comme représentant la plus haute qualité de semence de trèfle rouge au Canada et, les championnats remportés à "l'International Hay & Grain Show" Chicago, et à l'Exposition Royale de Toronto ont valu au district l'honneur d'une réputation mondiale. Les dix neufs exhibits exposés remportèrent en succession, à Chicago, Toronto, Ottawa, en moins de deux semaines un total de trente récompenses. C'est plus qu'il n'en fallait pour attirer l'attention du public, ouvrir des débouchés et réaliser avec le trèfle rouge ce que réussissaient les producteurs du comté de Peel avec la luzerne.

Le professeur Barton, doyen de la faculté d'Agriculture de l'Université McGill lors d'une conférence donnée à son retour d'Europe à la section locale de la C.S.T.A. à Ottawa, commentant la merveilleuse situation agricole qu'il a observée en France, attribuait une partie de ce succès à l'organisation de la production par zones. Ces observations s'appliquent particulièrement bien aux comtés de Prescott et Russell où la production de la graine de trèfle établie sur une base permanente et commerciale fait maintenant partie intégrale du système de culture.

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RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

Le Developpement de Notre Connaissance de la Nutrition. J.. B. Orr. Institut de recherche Rowett, Aberdeen, Ecosse.

Dans ce résumé d'une conférence faite à la C. S. T. A. lors du congrès annuel de Guelph en juin dernier, le Dr. Orr expose brièvement le développement de nos connaissances actuelles en nutrition.

Il fait ressortir la valeur de l'instinct des animaux qui conduit ceux-ci à choisir la nourriture qui leur est propre. Il montre que beaucoup de nos habitudes en matières de

nutrition animale sont basées sur cet instinct. Beaucoup des principes de nutrition que nous décrivons aujourd'hui en langage technique sont connus des cultivateurs depuis de longues années. La science moderne peut-elle ajouter quelque chose à cette connaissance pratique? Il est certainement possible d'économiser du temps à l'aide des méthodes scientifiques modernes. L'ancien système par tâtonnement laissait trop au hasard.

Il est possible qu'il y ait des composants de la nourriture animale qui n'aient pas encore été découverts. La science moderne les découvrira peut-être quelque jour en nous montrant leur valeur. Au lieu d'insister sur le nombre de calories ou les protéines ou les vitamines qu'une ration nutritive contient nous avons maintenant atteint une période oû il nous est possible d'avoir des vues plus larges et de considérer la ration nutritive dans son ensemble. Le Canada doit nécessairement transformer une partie de son grain en viande, en lait, en oeufs. La nutrition animale offre un vaste champ à l'expérimentation au Canada.

La Gomme des Blessures Chez le Pecher et Chez la Vigne. Son influence sur les attaques des parasites cryptogamiques des blessures. R. S. Willison. Laboratoire fédéral de Pathologie Végérale.

La première partie de cette thèse paraît dans ce numéro. Dans cette partie sont passées en revue les publications sur le sujet et décrites les expériences entreprises.

La Seconde partie donne les résultats obtenus. Elle paraîtra dans le prochain numéro accompagnée de dessins et de photographies. Un sommaire de la thèse entière sera donné à ce moment-là.

Utilisation des Renseignements d'Ordre Economique dans le Travail de Vulgarisation. W. V. Longley. Collège d'Agriculture de la Nouvelle Ecosse, Truro, N.E.

Ce travail a été lu à la réunion annuelle de la Société Canadienne d'Economie Agricole à Guelph en juin dernier. Le Dr. Longley y montre combien il est important de fournir des renseignements économiques précis à ceux qui sont engagés dans le travail de propagande agricole. Il leur est nécessaire par exemple d'avoir des renseignements sur les divers systèmes culturaux de façon à développer le type d'agriculture le mieux adapté à un district particulier au moyen d'organisations agricoles, etc. Le Canada devrait publier des "aperçus agricoles" dans lesquels seraient donnés les tendances qui se dessinent ainsi que des prévisions concernant les prix des produits agricoles. Ce genre de renseignements a été beaucoup développé aux Etats-Unis.

Il est important aussi de développer la tenue et l'étude de livres de comptabilité sur les exploitations agricoles de façon à pouvoir faire des recommandations précises concernant l'organisation et le budget de l'exploitation. Il est important que des renseignements analogues soient obtenus par les producteurs en ce qui concerne l'organisation de la distribution et les prix obtenus sur les divers marchés par les différents produits agricoles. Le travail fait par les cercles de jeunes gens et de jeunes filles constitue une base sérieuse dans cette direction.

Il est important d'établir un programme à longue échéance basé sur des données économiques sérieuses.

Quelques Facteurs Influencant le Poids des Oeufs. W. R. Graham, Jr. Collège d'Agriculture de l'Ontario, Guelph, Ont.

Cette étude est basée sur les chiffres obtenus par le British Empire Marketing Board,— Ontario Government Experiment, et concerne les facteurs couvrant les probabilités d'éclosion.

Il y a une relation étroite entre le poids de l'oeuf mis dans l'incubateur et le poids du poussin à l'éclosion, bien que le poids de l'oeuf n'aie pas d'effet sur la probabilité de l'éclosion, tout au moins entre des limites normales.

Il y a une relation étroite entre le poids maximum atteint par des poulettes Barred Plymouth Rock dans la période février-juillet inclus et le poids moyen de leurs oeufs pondus dans la même période. Le poids d'une poulette pendant un mois déterminé est un moins bon indice du poids de ses oeufs que le poids maximum atteint par l'oiseau pendant les mois février-juillet inclus. Aucune relation n'a pu être établie entre le poids des oeufs produits et les divers concentrés de protéines donnés en nourriture à l'oiseau.

L'addition d'huile de foie de morue à la ration alimentaire a provoquée une légère augmentation du poids des oeufs pendant la période février-juillet.

CURRENT PUBLICATIONS

57. Report on the Organization of Potato Marketing. Ministry of Agriculture and Fisheries. H. M. Stationery Office, London.

This report stresses the areas of production, consumption and price trends in England and Wales, the organization of the trade and trade practices in handling potatoes and the weakness of the existing system. Two sections are devoted to descriptions and analysis of the structure and operation of potato marketing organizations in England and Wales and in other countries. The Prince Edward Island Potato Growers Association, The Quebec Federated Co-operative Control of Marketing in British Columbia are included.

The Report also outlines a plan which presumably would be set up under the Agricultural Marketingtural Marketing Act of 1931. "Both because the chief potato producing areas of this country are clearly defined and for reasons of business efficiency, a federal form of organization seems to be desirable." J.C.

58. Hedges and Their Uses. W. T. Macoun. Bulletin 142, New Series, Dominion Department of Agriculture, Ottawa, Ont.

The collection of hedges at the Central Experimental Farm, Ottawa, is one of the largest in the world. Since the planting of sample hedges was begun in 1889, no less than one hundred and thirty-six species and varieties of trees and shrubs have been tested for hedge purposes. Dr. Macoun gives a report of these tests and a description of the species best suited. Duplicate tests have been run at twenty Experimental Stations in Canada, and a bulletin gives recommendations for different parts of the country. The bulletin is exceedingly well illustrated with photographs taken by Dr. Frank T. Shutt, and by different members of the branch Experimental Farm staffs. Copies of the bulletin may be secured from the Publications Branch, Department of Agriculture, Ottawa.

59. Agricultural Policy in South Africa. Hubert D. Leppan. Published by the Central News Agency, Limited, Johannesburg, South Africa. Available from the Department of Agriculture Library, Ottawa, Ont.

The author, who is Professor of Agricultural Economics at the Pretoria University, succeeds in giving a background to agrarian policy in South Africa. Some idea of the task of directing agriculture in this part of the world may be gained from the following:

> "The diversity of South African conditions—spread from arid to humid country; from the cultivation of tropical to cool temperate crops; from intensive animal husbandry in dairying, poultry and pigs, to the extensive farming of nondescript sheep and goats, and so forth—renders the formulation of common policy difficult, and at times, impossible. A comparative homogeneity of circumstances as found say, in New Zealand, would make the task relatively easy, but because the Union's situation is intricate, is no reason why a constructive policy should not be followed—in fact it makes it more imperative."

> "The chief limitation to the production from South African farming lies in inadequate moisture supplies and in consequence the amount of arable land available is restricted to only a small fraction of the area of the country. Palpably then to utilise the natural farming resources of the Union the animal industry should dominate the outlook. Moreover, the trend in the trade in agricultural commodities on international markets seems to favour foodstuffs from animals. Prices of the products from cultivation have dropped enormously and if the output of these foreshadowed materialises then a fairly permanent lower price for these products is likely. Obviously then, apart from fruits, the comparative advantage in South African farming would appear to lie with the animal industry rather than with the production of crops for sale."

The book is divided into three sections, the first giving a general survey of the South African farming situation, the second giving a clear cut criticism of agrarian policy in South Africa, and the third giving a brief essay on the lot of the farmer. This last section is a thoughtful contribution on some of the points now being raised regarding the status of farmers in general.

A treatise on Canadian Agricultural Policy, written along the same fearless lines as Professor Leppan's book, would undoubtedly be of value at the present time. —H.L.T.

60. THREE MORE PLANT PATENTS. Robert C. Cooke. The Journal of Heredity, Vol. 22, December 1931.

The patenting of varieties of plants forms an interesting subject for discussion in this article. It is pointed out that three of the patents issued have been for plants which were mutations, and the question is raised as to whether such varieties are really inventions. While it is probable that the inventor could not produce exact duplicates by the same methods which he describes as having produced the original, yet having once produced a new variety, one does not have to produce a duplicate by breeding but reproduces the new variety by vegitative methods. A contrast is drawn between the plant breeder who exercises his art through hybridization and selection, and the "inventor" who suddenly finds a mutant in a row of plants of a known variety which he is simply growing. Can such a man be called an "inventor", and should he be issued a patent for "skill" in producing a new variety? Apparently the United States Patent Office thinks so, for patents have been issued on this basis.

61. OPERATIONS OF THE POULTRY PRODUCERS OF SOUTHERN CALIFORNIA INC. University of California, College of Agriculture Bulletin 516, J. M. Tinley and E. A. Stockdyk.

This study was undertaken for the purpose of analyzing (1) the condition under which eggs are marketed in Los Angeles and (2) the operations of the poultry producers of Southern California, Inc.

It was desired to know whether since 1917 when the poultry producers began operation there had been any material changes in the supply and demand situation or in the market structure which made it difficult for the association to "continue to operate successfully" and whether there was a place for a Co-operative Association in marketing eggs in Los Angeles and what its structure and policies should be.

Comparisons of the structure and operating policies of the Southern California Poultry Producers Inc. are made with those of the Poultry Producers of Central California, the Challenge Cream and Butter Association, and the San Diego Co-operative Association.

It was found that egg marketing conditions have changed considerably since 1916. The association was handicapped by its form of organization in modifying its sales methods and policies in order to meet the new conditions. - - - It is considered that if eggs are to be marketed successfully by a cooperative association in Southern California they must be handled in conjunction with poultry feeds and other poultry products.

A plan of organization for a new association is provided which would combine the Poultrymen's Cooperative Milling Association and the Poultry Producers of Southern California Inc. This involves complete reorganization of the two cooperatives. —J.C.

62. STANDARD DESCRIPTIONS OF REGISTERED OAT VARIETIES. R. A. Derrick. Central Experimental Farm, Ottawa, Ont.

This bulletin fulfils a long felt need in the Canadian seed business. Most of the available classifications were non-Canadian and did not take into account Canadian environmental characteristics. The descriptions listed are of varieties accepted for registration in Canada, by the Canadian Seed Growers Association, viz., Banner, Victory, Alaska, O.A.C. 72, O.A.C. 144, O.A.C. 3, Abundance and Gold Rain. Descriptions given follow closely the plan outlined by the C.S.G.A. Committee on Norms. This bulletin is very well illustrated, principally with photographs by Mr. P. R. Cowan, and is available from the Publications Branch, Department of Agriculture, Ottawa.

63. CANADA 1932. The official handbook of present conditions and recent progress, Dominion Bureau of Statistics, Ottawa.

This valuable handbook is an exceedingly convenient pocket size compilation of information which appears in more detail and at a later date in the Canada Year Book. The latter publication is too costly for general distribution. The handbook enables one to get a grasp of the general conditions and recent progress of the Dominion quickly and easily. It covers the commercial and industrial and agricultural fields and contains considerable historic material as well. It should be in the library of every well informed Canadian.

64. The International Yearbook of Agricultural Statistics.

The International Institute of Agriculture at Rome has recently published the 1930-31 edition of the "International Yearbook of Agricultural Statistics".

This volume of 830 pages is the result of the most extensive and detailed inquiry made in the domain of international agricultural statistics and constitutes a work of the greatest importance to all those who are interested in questions having a direct or indirect relation to production and commerce of agricultural products.

In the first part of the Yearbook are classified the figures for area and population in the years nearest to 1913 and 1930 for 220 countries: the presentation of these figures throws light upon the world situation from the geographical, political and demographical points of view during both the pre-war and post-war periods. The second part is composed of a series of tables comprising for nearly 50 countries the available data concerning the uses for which the total area is employed, the apportionment of cultivated areas between the different crops, agricultural production, numbers of th different kinds of livestock and the products derived from them. In the tables constituting the third part of the volume, have been indicated for nearly 40 agricultural products, the area, production and yield per acre in each country during the last five years of the pre-war period and during each of the years from 1927 to 1930.

For each kind of livestock all available figures in the different countries have been grouped for the years 1913 and 1926 to 1930. A large part of the volume is devoted to statistics of the commercial movement of 42 vegetable products and 12 products of animal origin. The figures published relate to the imports and exports during the calendar years and for the cereals also during the commercial seasons.

It may be added that the tables of production and commerce not only specify details for each country but also the totals for the different continents and hemispheres and for the whole world, allowing the formation of a general idea of th changes taking place during the periods under consideration in the area under each crop, quantities harvested and the commercial movement in each product.

The part devoted to prices contains the weekly quotations of 25 agricultural products on the principal world markets for the year 1913 and for the period January 1927 to July 1931. In the freights section will be found the quotations for the transport of wheat, maize and rice on the most important shipping routes, and in the section reserved for fertilizers and chemical products useful in agriculture are published statistics of production, trade and prices for 15 products. In the rates of exchange section are set out the rates on the New York exchange for the most important currencies and in the Appendix have been brought together special chapters on the importance and distribution of the agricultural population, the distribution of agricultural holdings according to their size and mode of tenure and forestry.

The volume has also been enriched by a long introduction and a chapter of explanatory notes.

65. Crested Wheat Grass. L. E. Kirk. Bulletin published by the Department of Field Husbandry, University of Saskatchewan, Saskatoon, Sask.

In this bulletin Dr. Kirk describes a new grass (*Agropyron tenerum*) which has been the subject of investigation at the University of Saskatchewan since 1915. This grass was first brought to America in 1898 by the United States Department of Agriculture from its native habitat in the Volga region of European Russia. It is a cool climate crop, hardy in winter and beginning growth very early in the spring. It is long-lived perennial that maintains productiveness for many years, and has special merit for arid and semi-arid regions. It yields a good crop of hay which is palatable and nutritious, and stands up well under close grazing at both ends of the summer season when it is most needed. In addition to its use as farm forage, it is an excellent turf grass throughout the Prairie Provinces for farm lawns, town boulevards, school grounds and other places where it is not possible to apply water artificially. A strain which has been developed by the Field Husbandry Department, Saskatoon, has been given the variety name "Fairway".

CONCERNING THE C.S.T.A.

Organization for Winnipeg Convention

The Manitoba Branch of the C.S.T.A. is actively engaged in making plans for the Winnipeg Convention to be held the week of June 13th at the Manitoba Agricultural College. The general convention committee consists of Messrs. H. B. Sommerfeld, R. D. Colquette and W. R. Leslie. Sub-committee Chairmen have been named as follows: Entertainment, J. H. Evans; Reception, F. E. Foulds; Programme, W. C. McKillican; Registration, F. J. Greaney; Ladies Reception and Entertainment, Mrs. G. P. McRostie; Publicity, G. Batho; and Transportation, H. E. Wood.

The Convention of the Canadian Seed Growers Association will probable open on Saturday, June 11th, and run until Wednesday, June 15th. Invitations have been extended to several affiliated societies and groups to join with the C.S.T.A. in holding their annual sessions. The main sessions of the C.S.T.A. will be held on Thursday, Friday and Saturday, June 16 to 18. Sessions of affiliated groups will be mainly on June 15 and 16. The following societies and groups have been invited to hold their sessions at Winnipeg on these dates: Canadian Society of Agricultural Economics, Secretary, J. F. Booth, Commissioner of Agricultural Economics, Ottawa; Western Canada Society of Animal Production, Secretary, L. B. Thomson, Dominion Range Experimental Station, Manyberries, Alta.; Western Canadian Society of Agronomy, Acting Secretary, F. E. Foulds, Dominion Seed Branch, Winnipeg, Manitoba; Canadian Phytopathological Society, Secretary T. G. Major, Tobacco Division, Central Experimental Farm, Ottawa; Horticultural Group, Secretary, M. B. Davis, Division of Horticulture, Central Experimental Farm, Ottawa; Soils Group, Provisional Secretary, A. H. Joel, University of Saskatchewan, Saskatoon, Sask.; Engineering Group, Acting Secretary, L. G. Heimpel, Department of Agricultural Engineering, Macdonald College, P.Q.

Programmes for the meetings for several of these societies and groups are well under way and it is expected that the complete convention programme will be published in the May issue of *Scientific Agriculture.*

Danish Educational Tour

The White Star Line is organizing an educational tour through Denmark and central Europe. The party is sailing on June 27th via the S.S. Laurentic. The party will visit England, Germany, Switzerland, France and Denmark. Eight days will be spent in studying the educational methods, co-operative systems, and cultural aspects of Denmark. The charge for the tour covering all expenses is $600.00, with lower rates if twenty-five avail themselves of the opportunity. Further information may be secured from the General Secretary of the C.S.T.A., 306 Victoria Building, Ottawa, Ont.

Founder's Day at Macdonald College

The 25th Anniversary of the founding of Macdonald College was fittingly observed on Wednesday, February 10th, 1932.

Following a banquet in the main dining hall, the gathering was addressed in the assembly hall by Sir Arthur Currie, G.C.M.G., K.C.B., Principal of McGill University. He paid fitting tribute to the foresight and generosity of Sir William C. Macdonald, the founder of the institution. An excellent concert was given by the Royal Bank Men's Choir, with the assistance of outstanding soloists.

A memorial brochure has been issued by the College, giving Sir Arthur Currie's address, an appreciation of Sir William Macdonald, by Susan Vaughan, Warden of the Royal Victoria College, and a description of the work of the School of Agriculture by Dean G. H. S. Barton, the work of the School of Teachers by Dean Sinclair Laird, and the work of the School of Household Science by Miss Bessie M. Philp, Director. The brochure contains a very fine aerial view of the College and surrounding country.

Macdonald College Announces Graduate Courses in Animal Industry

Under the auspices of the Faculty of Graduate Studies of McGill University, advanced courses, leading to the degree of M.Sc., in three branches of Animal Industry have been outlined and announced. Courses are offered in Applied Animal Nutrition, Applied Animal Breeding, and Animal Parasitology. The department is under the direction of Dean Barton

and lists the following staff:—Dr. R. L. Conklin, Professor of Animal Pathology, Dr. C. L. Huskins, Dept. of Botany, McGill University, Research Professor in Animal Parasitology to be appointed, Mr. W. A M.aw, Assistant Professor of Poultry Husbandry, Mr. E. W. Crampton, Assistant Professor of Animal Husbandry, and Mr. A. J. G. Maw, Lecturer in Poultry Husbandry.

Prerequisites include standing of at least high second class in the undergraduate courses at Macdonald College or equivalent work elsewhere, including such undergraduate subjects as are necessary for the particular line of graduate study to be undertaken. Through this plan of organization, related work is consolidated in one department, a range of contacts is available to the students and joint effort is possible for the staff.

Notes and News

J. F. Fraser (Toronto '23) Poultry Instructor at the Kemptville Agricultural School, has been elected President of the Canadian Poultry Records Association. This organization handles all registration of Poultry in Canada.

W. K. Bunner (Toronto '23) formerly Agricultural Missionary at Achimota College, Accra, Gold Coast, South Africa, is now attending College of Education in Toronto, and living at 130 Hogart Avenue, Toronto 6.

A. E. Clarke (Alberta '24) is now taking Post Graduate work in the Department of Genetics, University of California, Berkeley, California.

E. Dubé (Laval '31) is now located at St. Donat, Rimouski, P.Q.

J. L. Webster (Toronto '25) has been appointed to the position of lecturer in Horticulture on the staff of Macdonald College. Mr. Webster is the son of one of the pioneer fruit growers of British Columbia, and is the owner of an orchard in the Okanagan Valley. For several years after graduation, he managed a large orchard and packing house at Vernon, B.C., and for the past four years has been Assistant Horticulturist for the Southern Oknagan and Similkameen Districts with headquarters at Penticton.

O. R. Evans (Toronto '25) was married on January 30th to Miss Mary Lothian at Montreal.

J. A. Ste. Marie (McGill '16) Superintendent of the Dominion Experimental Farm at Ste. Anne de la Pocatière, has been elected President of the Canadian Ayrshire Association.

W. A. Dempsey (Toronto '30) Edgewater Farm, Belleville, Ont., has been elected President of the Canadian Chanticleer Breeders Association.

Miss H. I. Milne (British Columbia '27) Poultry Instructor at the University of Alberta, Edmonton, has been granted the Degree of Master of Science by the University of Alberta.

W. V. Longley (Toronto '11) Director of Extension, Truro, N.S., and Mrs. Longley were presented with a grandfather clock at the close of the annual extension conference at Truro. The presentation was made on behalf of Provincial and Federal extension men in the Province of Nova Scotia, and other agricultural workers operating in the Maritime Provinces as a whole.

F. J. Greaney (Toronto '22) Plant Pathologist at the Dominion Research Laboratory, Winnipeg, has been awarded the Degree of Doctor of Philosophy by the University of Minnesota. Dr. Greaney did most of his work under Dr. Stakman and was commended for his thesis on "The Prevention of Cereal Rusts by the use of Fungicidal Dusts."

R. A. Fisher (British Columbia '22) Assistant Chemist, Department of Soils, University of Saskatchewan, is taking graduate studies at the University of Maryland, College Park, Maryland.

New Members

The following applications for regular membership has been received since February 1st:

Felix Arsenault (Laval 1930, B.S.A.), Rimouski, P.Q.

L. Belanger (Laval 1931, B.S.A.), Montmagny, P.Q.

A. Desrosiers (Montreal 1930, B.S.A.), Nicolet, P.Q.

COMMITTEE ON RESEARCH

Secretaries of locals who have formed sub-committees on research are requested to send reports of their activities direct to Dr. W. H. Brittain, Chairman, Research Committee, Macdonald College, Que., not later than April 1st. Members of the Committee representing sections or affiliated organizations are urged to have their reports in by the same date.